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SITE: Smokey Mountain
BREAK: 1.9
OTHER: VS

SITE INVESTIGATION REPORT

Potential Hazardous Waste Site

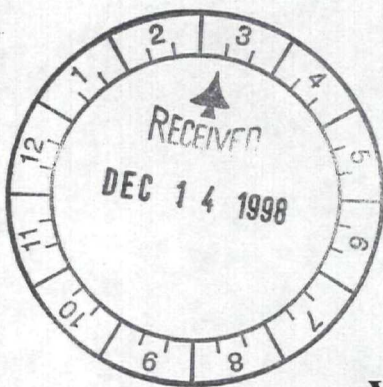
SMOKEY MOUNTAIN SMELTERS
KNOX COUNTY, TENNESSEE 37920
TN DIVISION OF SUPERFUND SITE # 47559
EPA ID # TN0002318277



Prepared for:
U.S. Environmental Protection Agency

Wragg ID #
Juni Cunniff
11/2/99

Prepared by:
Tennessee Department of Environment and Conservation
Division of Superfund-Knoxville Field Office
2700 Middlebrook Pike, Suite 210
Knoxville, TN 37921
423-594-5479



VOLUME 2 - REFERENCES



10598152

LIST OF REFERENCES

<p style="text-align: center;">SMOKEY MOUNTAIN SMELTERS 1508 MARYVILLE PIKE KNOXVILLE, TENNESSEE 37920 U.S. EPA # TN0002318277 TSDF #47-559</p>	
1	Burress, J. 1994. (Plant Manager, Smokey Mountain Smelters). Letter to D. Henshaw (Knox County Air Pollution Control), RE: operations, May 3.
2	Crabtree, J. 1983. (TDEC/Division of Solid Waste Management). Letter to D. Johnson (Smokey Mountain Smelters), RE: Geologic Evaluation of Proposed Industrial Storage Yard and Landfill, November 18.
3	Duncan, J. 1983. (Congress of the United States). Letter to J. Lovett (Director of Knox County Department of Air Pollution Control), RE: Complaint, July 27.
4	FEMA. 1983. Flood Insurance Rate Map. Knox County, Tennessee (Unincorporated Areas), Federal Emergency Management Agency. Community-Panel Number 475433 0190 B, Panel 190 of 235. May 16.
5	Hawley, G. 1981. <u>The Condensed Chemical Dictionary</u> , Tenth Edition. New York:Van Nostrand Reinhold Company, Inc. pgs. 41,288, 394, 622-3, and 927.
6	Howard, P. 1991. <u>Handbook of Environmental Fate and Exposure Data for Organic Chemicals</u> , Volume III, Pesticides. Chelsea, MI: Lewis Publishers. pgs. 11-23, 90-109, 267-277, 385-427.
7	IT. 1990. International Technology Corporation Analytical Services. "Analytical Results of Sample". September 24.
8	KCDAPC. 1980. Permit Application, Form APC-1. Received by the Knox County Department of Air Pollution Control, filed by Dan E. Johnson, President, Smokey Mountain Smelters, Inc. November 7.
9	KCDAPC. 1983. Facility Inspection Report, David Witherspoon, Inc. - Witherspoon and Johnson Dump. Inspected by the Knox County Department of Air Pollution Control, December 5.
10	KCDAPC. 1984. "Disposal of Slag from RF/SMS operations", memo to L.L., J.C., J.L. (KCAPC), from W. Schaad, dated February 8.
11	KCDAPC. 1985. "David Witherspoon - Historical Record", Knox County Department of Air Pollution Control.

(continued)

LIST OF REFERENCES (continued)

<p>SMOKEY MOUNTAIN SMELTERS 1508 MARYVILLE PIKE KNOXVILLE, TENNESSEE 37920 U.S. EPA # TN0002318277 TSD #47-559</p>	
12	KCDAPC. 1989. "List of complaints, inspections, and Departmental action", Knox County Department of Air Pollution Control, August 10.
13	Maupin, B.H. (TDEC/DSF). 1997a. Estimation of the groundwater pathway secondary target population. December 1997.
14	Maupin, B.H. (TDEC/DSF). 1997b. Hazardous waste quantity calculation. December.
15	Maupin, B.H. (TDEC/DSF). 1997c. Letters to Daniel E. Johnson (Property Owner), RE: Site Entry - Smokey Mountain Smelters. Tennessee Department of Environment and Conservation/Division of Solid Waste Management. September 9.
16	Maupin, B.H. (TDEC/DSF). 1997d. "Features within a four miles radius of Smokey Mountain Smelters". December.
17	Maupin, B.H. (TDEC/DSF). 1997e. "Home and unspecified-use wells within a four miles radius of Smokey Mountain Smelters". December.
18	Maupin, B.H. (TDEC/DSF). 1997f. Potential Hazardous Waste Site - Site Identification ("Discovery") August 6.
19	Maupin, B.H. 1997g. "WHPA near SMS", memo to Files (DSF), dated November 21.
20	Maupin, B.H. 1998a. "Study Plan-Site Screening Investigation". Tennessee Department of Environment and Conservation, Division of Superfund, August 21.
21	Maupin, B.H. 1998b. "Contaminant occurrences tabulated by type of contaminant, then by type of media." Tennessee Department of Environment and Conservation, Division of Superfund, November 30.
22	NARA (National Archives and Records Administration). 1996. <u>Code of Federal Regulations</u> , Title 40: Protection of Environment, Part 421: Nonferrous Metals Manufacturing Point Source Category, Subpart C, Item 421.30 (Washington D.C. Government Printing Office).
23	NARA (National Archives and Records Administration). 1997. <u>Code of Federal Regulations</u> , Title 40: Protection of Environment, Part 261: Identification and Listing of Hazardous Waste, Subpart D, Item 261.32 (Washington D.C. Government Printing Office).

(continued)

LIST OF REFERENCES (continued)

SMOKEY MOUNTAIN SMELTERS
1508 MARYVILLE PIKE
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U.S. EPA # TN0002318277 TSDF #47-559

24	NARA (National Archives and Records Administration). 1997. <u>Code of Federal Regulations</u> . Title 40: Protection of Environment, Part 464: Metal Molding and Casting Point Source Category, Subpart A, Item 464.10 (Washington D.C. Government Printing Office).
25	NARI. 1973. <u>Standard Classification for Nonferrous Scrap Metals</u> . National Association of Recycling Industries, Inc., Circular NF-73, April 1. pgs 1-8.
26	OMB. 1987. <u>Standard Industrial Classification Manual</u> . Executive Office of the President, Office of Management and Budget, pgs 146-8.
27	SMS/MEC. 1980. Bailment and Security Agreement, Bailee-Debtor: Dan E. Johnson (Smokey Mountain Smelters, Inc.), Bailor-Secured Party: Morris Lefton (Metals Exchange Corporation), April 18.
28	STN. 1980. State of Tennessee, Uniform Commercial Code-Financing Statement-Form UCC-1, Debtor: Smokey Mountain Smelters, Inc., Secured Party: Metal Exchange Corporation, April 18.
29	TDC/Division of Geology (DG). 1956. " <u>Ground-Water Resources of East Tennessee</u> ". State of Tennessee, Department of Conservation, Division of Geology. Bulletin 58, Part 1, pp. 6-9, 12, 43-4, 245-68, Plate 9 (See Figure 5, "GEOLOGIC MAP").
30	TDEC/Division of Natural Heritage (DNH). 1997. "Project review information for endangered species and critical or sensitive habitat," memorandum to F. Grubbs (TDEC/DSF/NCO) from A. Barass (TDEC/DNH), dated October 8. Smokey Mountain Smelters Project, along Flenniken Branch to Tennessee River, near Knoxville, Knox County, TN.
31	TDEC/Division of Water Pollution Control (DWPC). 1995. <u>State of Tennessee Water Quality Standards</u> , Chapter 1200-4-4, Use Classifications for Surface Waters. July. pp: 354-6.
32	TDEC/DWPC. 1996. Tennessee Fishing Advisories. Tennessee Department of Environment and Conservation. March 1992, revised May 1996.
33	TDEC/Division of Water Supply (DWS). 1997a. Records of Water Wells on the Knoxville Quadrangle (0147NW) TN. November 12. Pp.:13-23.

(continued)

LIST OF REFERENCES (continued)

SMOKEY MOUNTAIN SMELTERS
1508 MARYVILLE PIKE
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277 TSDF #47-559

34	TDEC/DWS. 1997b. Records of Water Wells on the Maryville Quadrangle (0147SW) TN. November 12. Pp.:35-43.
35	TDEC/DWS. 1997c. Records of Water Wells on the Shooks Gap Quadrangle (0147NE) TN. November 12. Pp.:1-12.
36	TDHE/Division of Solid Waste Management (DSWM). 1983. "Field/Activity Report", by J. Crabtree (DSWM), dated March 23.
37	TDHE/DSWM. 1983. "Report of Geologic Investigation", by G. Pruitt (DSWM), dated November 4.
38	TDHE/DSWM. 1990. Tennessee Department of Health and Environment, Special Solid Waste Notice of Approval (Letter #2468/2640), issued to Smokey Mountain Smelters, Inc. October 12.
39	TVA. 1993. "Tennessee Valley Reservoir and Stream Quality - 1993". Tennessee Valley Authority, Division of Water Management, May 1994.
40	TWRA. 1993. "Fort Loudoun Reservoir Annual Report". Tennessee Wildlife Resources Agency, region IV. Prepared by D. Peterson and J. Negus.
41	USBC 1990. United States Bureau of the Census. 1990 US Census Data.
42	USDA/SCS. 1955. <u>Soil Survey / Knox County Tennessee</u> , (with map). U.S. Department of Agriculture/Soil Conservation Service. August. pages: 4-9, 12-27, 102-5, 116-19, 136-7, 198-203, 220-23, 226-7, 230-1, 234-5, 238-9, and Soil Map - Knoxville Quadrangle (Figure 6 - Soil Map).
43	USDC. 1993. Rainfall Frequency Atlas of the United States. U.S. Department of Commerce, Hydrologic Services Division. July. Chart 44, page: 95.
44	USDC/NOAA. 1968. <u>Climatic Atlas of the United States</u> . U. S. Department of Commerce, National Oceanic and Atmospheric Administration. June. page: 78.
45	USDHHS. 1994. <u>Pocket Guide to Chemical Hazards</u> . U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, June. pgs 14-15.

(continued)

LIST OF REFERENCES (continued)

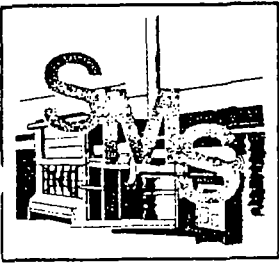
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46	USDHHS. 1998. Health Consultation. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation, August 27. pgs 1-4.
47	USEPA. 1990. Graphical Exposure Modeling System (GEMS) Database. U.S. Environmental Protection Agency. Compiled from U.S. Bureau of the Census Data (1990).
48	USEPA. 1998. Envirofacts Query Results, Zip Code 37920. U.S. Environmental Protection Agency. July 9.
49	USGS. 1966. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Tennessee: Knoxville (147-NW) 1966, scale 1:24,000.
50	USGS. 1978. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Tennessee: Knoxville (147-NW) 1978, scale 1:24,000 (see Figure 2, SITE PLAN).
51	USGS. 1979. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Tennessee: Maryville(147-SW) 1979, scale 1:24,000 (see Figure 2, SITE PLAN).
52	USGS. 1984. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Tennessee: Louisville (138-SE) 1968, photorevised 1984, scale 1:24,000 (see Figure 2, SITE PLAN).
53	USGS 1990. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Tennessee: Bearden (138-NE) 1978, photorevised 1990, scale 1:24,000 (see Figure 2, SITE PLAN).
54	USGS. 1987. U.S. Geological Survey, 7.5 minute series Topographic Quadrangle Maps of Tennessee: Shooks Gap (147-NE) 1979, photorevised 1987, scale 1:24,000 (see Figure 2, SITE PLAN).
55	Wark K. And Warner C. 1981. <u>Air Pollution - Its Origin and Control</u> , Second Edition. New York: Harper & Row. Pp: 97 and 477.
56	White, J. 1997. Directory of Tennessee Manufacturers. M. Lee Smith Publishers and Printers LLC.
57	White, J. 1995. Directory of Tennessee Manufacturers. M. Lee Smith Publishers and Printers LLC.

" Burress
(Plant Manager, Smokey Mountain Smelters)
Letter to Knox County Air Pollution Control "

Burress, J. 1994. (Plant Manager, Smokey Mountain Smelters). Letter to D. Henshaw (Knox County Air Pollution Control), RE: operations, May 3.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



MAY 3, 1994

DAVID HENSHAW
KNOX COUNTY AIR POLLUTION CONTROL
400 MAIN STREET
ROOM 339
CITY-COUNTY BUILDING
KNOXVILLE, TN 37902-2405

DEAR MR. HENSHAW,

I HAVE APPOINTED ALLEN WRIGHT TO BE MODERATOR OF OUR ACTIVITY AT SMOKEY MOUNTAIN SMELTERS EVERYNIGHT FROM 8:00 P.M. TO 2:00 A.M. FOR THE NEXT 2 WEEKS.

ALLEN IS INSTRUCTED TO KEEP A LOG ON THE TIME, DATE AND ANY EVENT THAT MAY ARISE. ALLEN WILL DRIVE OVER TO DAYLILY DRIVE AT LEAST TWICE EACH NIGHT. ALLEN IS INSTRUCTED TO CALL ME AT ANY TIME THERE IS A PROBLEM.

I HAVE CONTACTED HOWARD CONSTRUCTION ABOUT LEVELING THIS AREA AND COVERING WITH RED CLAY. MR. RAY HOWARD SAID THAT HE COULD BE HERE WEDNESDAY MAY 5, 1994 IF IT DOES NOT RAIN TO HARD.

WE HAVE 2000 LBS. OF LIME COMING TO COVER WHERE WE ARE REMOVING SLAG, THE LIME WILL BE APPLIED AFTER LEVELING AND BEFORE COVERING WITH RED CLAY.

WE HOPE TO COMPLETE THIS BEFORE FRIDAY MAY 6, 1994.

SINCERELY,

JAMES BURRESS
PLANT MANAGER
SMOKEY MOUNTAIN SMELTERS, INC.

JB/tdk

MAY 5 1994

" DSWM " Geologic Evaluation of Proposed Industrial Storage Yard and Landfill" "

Crabtree, J. 1983. (TDEC/Division of Solid Waste Management). Letter to D. Johnson (Smokey Mountain Smelters), RE: Geologic Evaluation of Proposed Industrial Storage Yard and Landfill, November 18.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



file

STATE OF TENNESSEE
DEPARTMENT OF HEALTH AND ENVIRONMENT
EAST TENNESSEE REGIONAL OFFICE
ALEX B. SHIPLEY REGIONAL HEALTH CENTER
1522 CHEROKEE TRAIL
KNOXVILLE, TENNESSEE 37920

November 18, 1983

Mr. Dan Johnson, President
Smokey Mountain Smelter, Inc.
1455 Maryville Pike
Knoxville, TN 37920

Dear Mr. Johnson:

At your request a geologic evaluation of a proposed industrial storage yard and landfill has been completed by the Division of Solid Waste Management. The site consists of approximately three acres and is located about three miles south from the center of Knoxville and is on the east side of Maryville Pike (see attached topographic map). The geologic evaluation was conducted by Mr. Glenn Pruitt, staff geologist of the Division of Solid Waste Management, and a copy of Mr. Pruitt's report is enclosed for your information.

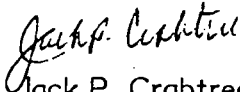
Based on the enclosed geologic evaluation, the Division of Solid Waste Management has concluded that this site is unsuitable for use as an industrial landfill. Furthermore, the site, without adequate weather protection, is not suitable for storage of industrial materials which have a potential for leaching into the soils of this site. The primary factor in determining the unsuitability of this site for use as a landfill was the insufficient soil development to allow for effectual sorptive buffer above bedrock and/or groundwater. Any leachate occurring here is likely to percolate more or less directly to bedrock, and while some contamination of groundwater would be almost a certainty, there is the imminent probability of lateral seepage and the eventual pollution of surface water.

In the event that Smokey Mountain Smelter, Inc., plans to use this site to continue storing the aluminum dross from the smelting operation, plans should be made to provide a method of protecting these materials from the weather. Otherwise this office recommends storage of the industrial materials at this location cease immediately and the materials presently on site should be relocated to an area where leaching will not potentially

Mr. Dan Johnson, President
Page 2
November 18, 1983

contaminate the surface and our groundwater of the area. Should you have questions relative to the enclosed geologic report, or if we may be of further assistance, do not hesitate to call.

Sincerely,



Jack P. Crabtree
Environmental Consultant
Division of Solid Waste Management

JPC:pjm E/4

Enclosure: Report of Geologic Investigation

cc: Knox County Health Department
Water Management Division - Regional Office
East Tennessee Regional Health Office
Nashville Office - DSWM

" Complaint "

Duncan, J. 1983. (Congress of the United States). Letter to J. Lovett (Director of
Knox County Department of Air Pollution Control), RE: Complaint, July 27.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

JOHN J. DUNCAN
20 DISTRICT, TENNESSEE

2458 RAYBURN HOUSE OFFICE BUILDING
PHONE: (AREA CODE 202) 225-5435

COUNTIES:
BLOUNT
KNOX
LOUDON
McMINN
MONROE
POLK

Congress of the United States
House of Representatives
Washington, D.C. 20515

July 27, 1983

COMMITTEE:
WAYS AND MEANS

SUBCOMMITTEES:
SELECT REVENUE MEASURES
HEALTH
OVERSIGHT

JOINT COMMITTEE ON
TAXATION

Mr. James Lovett
Director
Air Pollution Control Office
City/County Building
Suite L 222
400 Main Avenue
Knoxville, Tennessee 37902

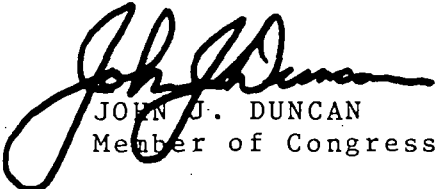
Dear Mr. Lovett:

I am attaching hereto a letter I have received from Mrs. Rosalie Taylor and Mrs. Haskell Brown, members of my constituency.

It would be greatly appreciated if you could investigate the allegations contained in their correspondence and furnish me with a reply suitable for forwarding to these ladies.

I thank you for your courtesy in this matter.

Very truly yours,


JOHN J. DUNCAN
Member of Congress

JJD:ba

Enclosure

RECEIVED

JUL 19 1983

JOHN J. DUNCAN, M.C.
KNOXVILLE

July 19, 1983
(b) (6)

Congressman: John J. Duncan:
Dear Sir;

Isn't there something that
can be done about the "Rotary Furnace"
on Maryville Pike? I have called the
Air Pollution Center again, and they are
still keeping this area surrounded by
the terrible smoke, fumes and odor. They
didn't even stop when we had the hot,
dry weather. We have a very hard
time sleeping at night. Right now,
(after a storm) it is cool, and very
pleasant weather, but I am going to
have to close my doors, and windows,
it's so bad. It is making my husband,
and I cough, and it's hard to
breathe at times, because that is all
we can breathe. It is now 9 o'clock
p.m., and it will be this way all
night. All we are asking you is
air to breathe. Will you help us please.
People from all around here said
it bothers them terribly, but they

were't sure where it came from, but we live across the street, and ~~some~~ every night our house is just surrounded by smoke. you can see it floating across the roof. This is what I call hazardous to your health.

Please contact some-one, and get them to correct this. The last time I called the Center-521-2488.

They came out, "A man was burning brush in his yard at the same time," they talked to the man, and sent out two trucks to put out the fire. I talked to them about the factory, and they went out there. Then I received a letter telling me they had made the man extinguish the fire, but the factory had no ventilation. This is hard to believe.

We heard that they made them move out of the city, because of the smoke, and fumes, and we sure hope something can be done.

Thank you,

Mrs Rachel Taylor & Mrs Thelma Brown

(b) (6)

(b) (6)

" Flood Insurance Rate Map "

FEMA. 1983. Flood Insurance Rate Map. Knox County, Tennessee (Unincorporated Areas), Federal Emergency Management Agency. Community-Panel Number 475433 0190 B, Panel 190 of 235. May 16.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

KEY

500-Year Flood Boundary

100-Year Flood Boundary

Zone Designations* With Date of Identification e.s., 12/2/74

100-Year Flood Boundary

500-Year Flood Boundary

Base Flood Elevation Line With Elevation in Feet**

Base Flood Elevation in Feet Where Uniform Within Zone

Elevation Reference Mark

Zone D Boundary

River Mile

**Referenced to the National

*EXPLANATION C

ZONE	
A	Areas of 100-y flood hazard fac
AO	Areas of 100-y are between one of inundation as are determined.
AH	Areas of 100-y are between on elevations are : are determined.
A1-A30	Areas of 100-y flood hazard fac
A99	Areas of 100-y protection syst elevations and
B	Areas between year flood; or c ing with average the contributin mile; or areas p (Medium shadin
C	Areas of minim.
D	Areas of undet
V	Areas of 100-y action; base fl not determined
V1-V30	Areas of 100-y action; base fl determined.
NO	

Certain areas not in the spe may be protected by flood

This map is for flood insur sarily show all areas subj all planimetric features out

For adjoining map panels, Panels.

INITIA

FLOOD INSUR

FLOOD INSUR / Interim map revision effect: Designations. Map revised March 18, 197 to add Special Flood Hazar Map revised May 16, 19 revise Corporate Limits.

Refer to the FLOOD date shown on this map i structures in the zones established.

To determine if flood i contact your insurance : Program at (800) 638-66

1000

NATI

FI

FLI

KT


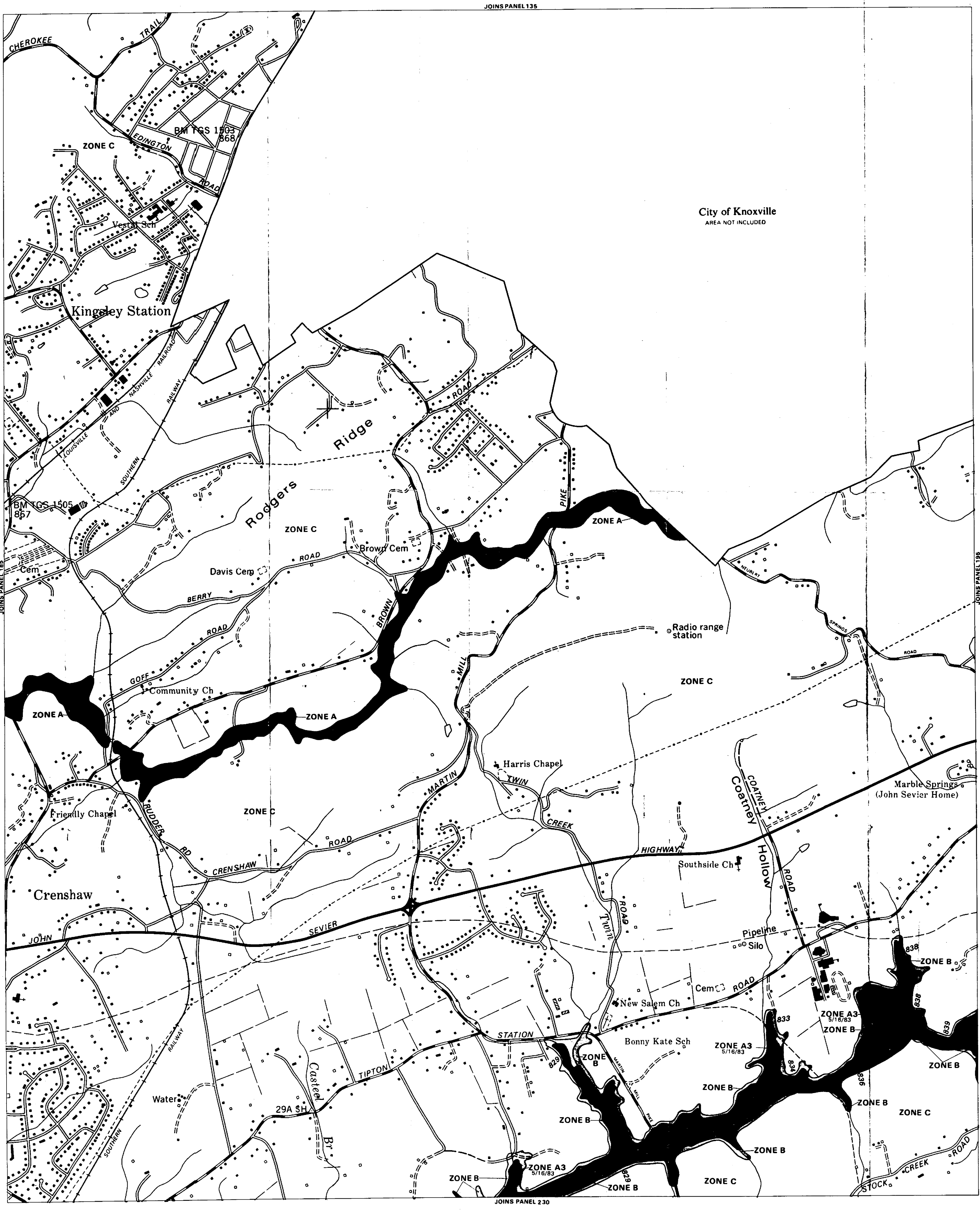
TI

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17559

" Chemical Dictionary Terms "

Hawley, G. 1981. The Condensed Chemical Dictionary, Tenth Edition. New York: Van Nostrand Reinhold Company, Inc. pgs. 41, 288, 394, 622-3, and 927.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



The
Condensed Chemical
Dictionary

TENTH EDITION

Revised by

GESSNER G. HAWLEY



VAN NOSTRAND REINHOLD COMPANY

NEW YORK

CINCINNATI

ATLANTA

DALLAS

SAN FRANCISCO

LONDON

TORONTO

MELBOURNE

preparations. Also used for water purification and treatment of sewage and plant effluent.

aluminum diacetate. See aluminum acetate.

aluminum diethyl monochloride. See diethylaluminum chloride.

aluminum diformate (aluminum formate, basic)
 $\text{Al}(\text{OH})(\text{CHO}_2)_2 \cdot \text{H}_2\text{O}$.

Properties: White or gray powder. Soluble in water. Low toxicity.

Derivation: Aluminum hydroxide is dissolved in formic acid and spray-dried. Solutions are also prepared by treating aluminum sulfate with formic acid, followed by lime.

Grades: Technical solutions (12–20° Bé).

Containers: Carboys; carlots.

Uses: Waterproofing; mordanting; antiperspirants; tanning leather; improving wet strength of paper.

aluminum distearate $\text{Al}(\text{OH})(\text{C}_{18}\text{H}_{35}\text{O}_2)_2$.

Properties: White powder; m.p. 145°C; sp. gr. 1.009.

Insoluble in water, alcohol, ether. Forms gel with aliphatic and aromatic hydrocarbons. Low toxicity.

Uses: Thickener in paints, inks, and greases; water repellent; lubricant in plastics and cordage; in cement production.

aluminum ethylate (aluminum ethoxide)



Properties: Colorless liquid which gradually solidifies; b.p. 200°C (6 mm); m.p. 140°C. Partially soluble in high-boiling organic solvents.

Derivation: Reaction of aluminum with ethyl alcohol, catalyzed by iodine and HgCl_2 .

Hazard: Strong irritant to eyes and skin.

Uses: Reducing agent for aldehydes and ketones; polymerization catalyst.

aluminum ethylhexoate (aluminum octoate). A metallic salt of 2-ethylhexoic acid, used as a gelling agent for liquid hydrocarbons used as paint additives.

aluminum fluoride, anhydrous AlF_3 .

Properties: White crystals. Sublimes about 1260°C without melting; sp. gr. 2.882. Slightly soluble in water; insoluble in most organic solvents.

Derivation: (1) Action of hydrogen fluoride gas on alumina trihydrate; (2) reaction of hydrofluoric acid on a suspension of aluminum trihydrate, followed by calcining the hydrate formed; (3) reaction of fluosilicic acid on aluminum hydrate.

Grades: Technical

Containers: Multiwall paper sacks; fiber drums.

Hazard: Moderately toxic; strong irritant to tissue. Tolerance (as F): 2.5 mg per cubic meter of air.

Uses: Production of aluminum to lower the melting point and increase the conductivity of the electrolyte; flux in ceramic glazes and enamels; manufacture of aluminum silicate; catalyst.

aluminum fluoride hydrate $\text{AlF}_3 \cdot 3\text{H}_2\text{O}$.

Properties: White crystalline powder. Slightly soluble in water.

Derivation: Action of hydrofluoric acid on alumina trihydrate and subsequent recovery by crystallization.

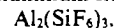
Grades: Technical; C.P.

Containers: Bags; drums.

Hazard: Moderately toxic.

Uses: Ceramics (production of white enamel).

aluminum fluosilicate (aluminum silicofluoride)



Properties: White powder. Slightly soluble in cold water; readily soluble in hot water.

Grades: Technical.

Hazard: Moderately toxic.

Uses: Artificial gems, enamels, glass.

aluminum formate. See aluminum triformate, and aluminum diformate.

aluminum formate, basic. See aluminum diformate.

aluminum formate, normal. See aluminum triformate.

aluminum formoacetate

$\text{Al}(\text{OH})(\text{OOCH})(\text{OOCCH}_3)$. White powder; soluble in water and alcohol; used in textile water repellents.

aluminum hydrate. See alumina trihydrate.

aluminum hydride AlH_3 .

Properties: White to gray powder; decomp. 160°C (100°C if catalyzed). Evolves hydrogen on contact with water.

Hazard: Dangerous fire and explosion risk.

Uses: Electroless coatings on plastics, textiles, fibers, other metals; polymerization catalyst; reducing agent.

Shipping regulations: (Rail, Air) Flammable Solid and Dangerous When Wet labels. Not acceptable passenger.

aluminum hydroxide. See alumina trihydrate.

aluminum hydroxide gel (hydrous aluminum oxide; alumina gel) $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$.

Properties: White, gelatinous precipitate. Constants variable with the composition; sp. gr. about 2.4. Insoluble in water and alcohol; soluble in acid and alkali. Nontoxic; noncombustible.

Derivation: By treating a solution of aluminum sulfate or chloride with caustic soda, sodium carbonate or ammonia; by precipitation from sodium aluminate solution by seeding or acidifying (carbon dioxide is commonly used).

Grades: Technical; C.P.; U.S.P. (containing 4% Al_2O_3); N.F. (dried, containing 50% Al_2O_3).

Containers: Fiber drums.

Uses: Dyeing mordant; water purification; waterproofing fabrics; manufacture of lakes; filtering medium; chemicals (aluminum salts); lubricating

Shipping regulations: (Rail, Air) Flammable Liquid label and Poison label. (Air) Not acceptable passenger (IATA).

crotonic acid (2-butenic acid; beta-methacrylic acid) $\text{CH}_3\text{CH}:\text{CHCOOH}$. Exists in cis and trans isomeric forms, the latter being the stable isomer used commercially. The cis form melts at 15°C and is sometimes called isocrotonic acid.

Properties: White crystalline solid; sp. gr. 0.9730; m.p. 72°C ; b.p. 185°C ; soluble in water, ethanol, toluene, acetone. Flash point 190°F (87.7°C) (C.O.C.). Combustible.

Derivation: Oxidation of crotonaldehyde.

Grade: 97%.

Containers: Glass bottles; fiber drums.

Hazard: Strong irritant to tissue.

Uses: Synthesis of resins, polymers, plasticizers, drugs.

Shipping regulations: (Rail, Air) Corrosive label.

crotonic aldehyde. See crotonaldehyde.

croton oil (tigilium oil).

Properties: Brownish-yellow liquid. Sp. gr. 0.935–0.950 (25°C); refractive index ($n_{40/D}$) 1.470–1.473.

Soluble in ether, chloroform and fixed or volatile oils; slightly soluble in alcohol.

Chief constituents: Glycerides of stearic, palmitic, myristic, lauric and oleic acids and croton resin, a vesicant.

Derivation: By expression from the seeds of Croton tigilium.

Hazard: Toxic; strong skin irritant; ingestion of small amounts may be fatal.

Use: Medicine (counterirritant, cathartic).

crotonolic acid. See tiglic acid.

crotonylene (2-butyne; dimethylacetylene)

$\text{CH}_3\text{C}:\text{CCH}_3$.

Properties: Liquid; b.p. 27°C .

Hazard: Flammable, dangerous fire risk. Moderate explosion hazard.

Shipping regulations: (Rail, Air) Flammable Liquid label.

crotyl alcohol (2-buten-1-ol, 3-methylallyl alcohol)

$\text{CH}_3\text{CH}:\text{CHCH}_2\text{OH}$.

Properties: Clear, stable liquid; sp. gr. 0.8550 ($20/20^\circ\text{C}$); boiling range $121\text{--}126^\circ\text{C}$; flash point (TOC) 113°F (45°C). Partially soluble in water (17%), wholly soluble in alcohol and ether. Combustible.

Hazard: Toxic by ingestion. Strong eye and skin irritant. Moderate fire risk.

Uses: Chemical intermediate; source of monomers; herbicide and soil fumigant.

crown filler. A mineral filler, usually calcium sulfate or carbonate or a mixture thereof used in paper manufacture.

crown glass. See glass, optical.

crucible. (1) A cone-shaped container having a curved base and made of a refractory material; used

for laboratory calcination and combustion. Some types are equipped with a cover. A Gooch crucible has openings in its base to permit filtration with suction; named after its inventor, an American chemist. (2) In the steel industry a special type of furnace provided with a cavity for collecting the molten metal.

crusher, gyratory. See gyratory crusher.

cryochemistry. That branch of chemistry devoted to the study of reactions occurring at extremely low temperatures (-200°C and lower). It permits synthesis of compounds that are too unstable or too reactive to exist at normal temperatures.

cryogenics. Study of the behavior of matter at temperatures below -200°C . The use of the liquefied gases, oxygen, nitrogen and hydrogen at about -260°C is standard industrial practice. Examples: Use of liquid nitrogen for quick-freezing of foods, and of liquid oxygen in steel production. Some electronic devices and specialized instruments, such as the cryogenic gyro, operate at liquid helium temperatures (about 4°K). Many lasers and computer circuits require low temperatures. See also superconductivity.

cryolite (Greenland spar, icetone) Na_3AlF_6 . A natural fluoride of sodium and aluminum, or made synthetically from fluorspar, sulfuric acid, hydrated alumina and sodium carbonate.

Properties: Colorless to white; sometimes red, brown or black; luster vitreous to greasy; hardness 2.5; sp. gr. 2.95–3.0. Refractive index 1.338; m.p. 1000°C ; soluble in concentrated sulfuric acid and in fused aluminum and ferric salts.

Occurrence: Greenland (only commercial source); Colorado; U.S.S.R.

Derivation: Synthetic product is made by fusing sodium fluoride and aluminum fluoride.

Uses: Electrolyte in the reduction of alumina to aluminum; ceramics; insecticide; binder for abrasives; electric insulation; explosives; polishes.

"Cryovac."³¹¹ Trademark for a light, shrink-film, transparent packaging material based on polyvinylidene chloride. Used especially for meats and other perishables.

cryptocyanine (1,1'-diethyl-4,4'-carbocyanine iodide) $\text{C}_{25}\text{H}_{25}\text{N}_2\text{I}$.

Properties: Solid; m.p. $250.5\text{--}253^\circ\text{C}$.

Use: Organic dye solution used as a chemical shutter in laser operation.

See also cyanine dye.

cryptoxanthin (provitamin A; hydroxy-beta-carotene) $\text{C}_{40}\text{H}_{56}\text{O}$. A carotenoid pigment with vitamin A activity.

Properties: Garnet-red prisms with metallic luster; m.p. 170°C ; soluble in chloroform, benzene, and pyridine; slightly soluble in alcohol and methanol.

Occurrence: In many plants, egg yolk, butter, blood serum. Can be made synthetically.

Uses: Nutrition; medicine.

"Dresinol."²⁶⁶ Trademark for 40 to 45% solids dispersions of rosins, modified rosins, or ester resins using aqueous ammonia as a dispersant plus a protective colloid stabilizing agent.

"Drewmulse."⁵⁵⁵ Trademark for a series of glycerol and glycol esters and sorbitan and polyoxyethylene sorbitan esters of fatty acids. Used as emulsifiers and opacifiers.

"Driacin."⁴¹⁶ Trademark for an ash-free organic salt of a hydrophobic, film-forming corrosion inhibitor. Uses: Sludge-dispersant additive for extending the storage life of cracked fuel oil and preventing filter or burner tip clogging; ingredient in rust-preventive formulations such as slushing oils.

"Dri-Clor."²⁰⁴ Trademark for a powdered laundry bleach with not less than 38% available chlorine.

"Dricoid."²⁰⁴ Trademark for a series of algin-emulsifier compositions.

"Dricoid." Sodium alginate.

K. Propylene glycol alginate-carrageenan.

KB. Propylene glycol alginate-vegetable gums.

Uses: Stabilizer-emulsifier compositions for ice cream and pressurized whipped cream.

drier. A substance used to accelerate the drying of paints, varnishes, printing inks and the like by catalyzing the oxidation of drying oils or synthetic resin varnishes, such as alkyds. The usual driers are salts of metals with a valence of two or greater and unsaturated organic acids. The approximate order of effectiveness of the more common metals is cobalt, manganese, cerium, lead, chromium, iron, nickel, uranium and zinc. These are usually prepared as the linoleates, naphthenates and resinsates of the metals. Paste driers are commonly the metal salts as acetates, borates, or oxalates dispersed in a dry oil. See also soap (2).

Note: The spelling "dryer" refers to equipment used for drying (of paper, textiles, food products, etc.).

"Drierite."³⁴⁵ Trademark for a special form of anhydrous calcium sulfate having a highly porous granular structure and a high affinity for water. Absorbs water vapor both by hydration and capillary action. Grades: Regular; Indicating (turns blue to red in use); "Du-Cal" (for drying air and gases.)

Uses: Drying of solids, liquids, gases.

"Dri-Film."²⁴⁵ Trademark for a group of silicone resins designed to impart durable moisture and weather resistance to surfaces.

Uses: Dri-Film 88 is used as a protective coating for electric motors, transformers, field coils, etc.; Dri-Film 144, a masonry water repellent; Dri-Film 1040 and 1042 imparts durable water repellency and other properties including water-borne spot and stain resistance, improved hand and drape, increased flex abrasion resistance, and improved tear strength and wrinkle recovery.

drilling fluid (drilling mud). A suspension of barytes and bentonite or attapulgite clay in either water or a petroleum oil. When circulated through oil-well drilling pipes, it acts as a coolant and lubricant and keeps the hole free from bore cuttings. To be effective it must have a specific gravity of at least 2.0 and should be thixotropic, with appreciable gel strength. Lignosulfonates are used as thinners in the water-based type. Oil-based muds require thickening additives such as blown asphalt and metallic soaps of tall oil and rosin acids.

"Driltreat."²³⁶ Trademark for a phosphatide liquid used as a stabilizer in oil emulsion drilling muds to offset effects of water contamination. Also effectively controls filtration.

"Drimix."²⁶⁷ Trademark for a form of dry dispersion of liquid or solid materials in a siliceous carrier. Also called dry liquid concentrates. Used to dry up liquids to convert them to free-flowing powders for easier handling in rubber and plastics industries.

"Drinox."⁴⁰¹ Trademark for a series of insecticides, used in seed treatment.

H-34. A liquid containing 24.5% heptachlor.

PX. A planter-box seed treatment containing 25% heptachlor.

Hazard: Highly toxic by ingestion, inhalation and skin absorption.

"Driocel."⁹⁹ Trademark for a solid, granular desiccant for drying process liquids and gases. Manufactured from a selected grade of natural bauxite, reduced to the required particle size, and thermally activated to its maximum absorbing activity. Mesh grades 4/8, 4/10, 8/14.

"Dri-Pax."²⁴ Trademark for a group of silica gel products used in packaging pharmaceuticals and similar packaged products. Extends shelf life and deodorizes products having unpleasant odors.

"Dri-Sol."³¹⁹ Trademark for low moisture nitrogen solutions used as, or in production of, soil fertilizers. Total nitrogen, % by wt, 46.2 to 58.5; approx. sp. gr. at 60/60°F, 0.930 to 1.162; lb/gal at 60°F, 7.75 to 9.68. Are composed of free ammonia, ammonium nitrate, and less than 0.5% by wt. of water.

"Drisoil."⁶⁴ Trademark for a group of chemically treated soybean oils, for replacement of linseed oil.

"Dritomic."⁵⁰ Trademark for a micron-fine wettable sulfur agricultural fungicide.

"Dri-Tri."¹ Trademark for sodium phosphate, tri-basic, Na_3PO_4 .

"Driwall."⁴⁴⁸ Trademark for transparent coatings (silicone); prevents water penetrating exterior walls of brick, stone, masonry.

dross. See slag.

groups, especially for pharmaceutical, perfume, and fine organic chemicals; converts esters, aldehydes, and ketones to alcohols, and nitriles to amines; source of hydrogen; propellant; catalyst in polymerizations.

Shipping regulations: (Rail, Air) Flammable Solid and Dangerous When Wet labels. Not acceptable passenger.

lithium aluminum hydride, ethereal. LiAlH_4 , plus ether.

Properties: Colorless solution in ether; very reactive to water.

Derivation: From lithium hydride and ether solution of aluminum chloride.

Hazard: Flammable; dangerous fire risk.

Use: See lithium aluminum hydride.

Shipping regulations: (Rail, Air) Flammable Liquid label. Not acceptable passenger.

lithium aluminum tri-tert-butoxyhydride (LATB; lithium tri-tert-butoxyaluminumhydride)

$\text{LiAl}[\text{OC}(\text{CH}_3)_3]_3\text{H}$.

Properties: White powder; sp. gr. 1.03. Stable in dry air but sensitive to moisture. Soluble in the dimethyl ether of diethylene glycol, tetrahydrofuran, diethyl ether; slightly soluble in other ethers.

Containers: Glass bottles.

Hazard: Evolves flammable hydrogen at 400°C. Dangerous.

Uses: For stereospecific reductions of steroid ketones and for reductions of acid chlorides to aldehydes.

Shipping regulations: Not listed. Consult authorities.

lithium amide LiNH_2 .

Properties: White crystalline solid; ammonia-like odor; sp. gr. 1.18; melts 380–400°C; decomposes in water, to form ammonia.

Derivation: Reaction of lithium hydride with ammonia.

Grades: 92–95% lithium amide.

Containers: 25-, 100-, 300-lb fiber drums.

Hazard: Flammable; dangerous fire risk. Do not use water to extinguish. (See "Lith-X").

Uses: Organic synthesis, including antihistamines and other pharmaceuticals.

Shipping regulations: (powdered) (Rail, Air) Flammable Solid label.

lithium arsenate Li_3AsO_4 .

Properties: White powder; sp. gr. 3.07 (15°C). Slightly soluble in water; soluble in dilute acetic acid.

Hazard: Highly toxic.

Shipping regulations: (Rail, Air) Arsenical compounds, n.o.s., Poison label.

lithium benzoate $\text{LiC}_7\text{H}_5\text{O}_2$.

Properties: White crystals or powder; soluble in water and alcohol. Low toxicity.

Derivation: Reaction of benzoic acid with lithium carbonate.

lithium bicarbonate LiHCO_3 . A lithium salt formed by dissolving lithium carbonate in water with excess

carbon dioxide. The solution, called lithia water, is used in medicine and prepared mineral waters.

lithium borate. See lithium tetraborate.

lithium borohydride LiBH_4 .

Properties: White to gray crystalline powder; decomposes in vacuum above 200°C; in air at 275°C; soluble in water, lower primary amines and ethers; sp. gr. 0.66; extremely hygroscopic.

Derivation: Reaction of sodium borohydride and lithium chloride.

Containers: Glass bottles.

Hazard: Flammable; dangerous fire and explosion risk.

Uses: Source of hydrogen and other borohydrides; reducing agent for aldehydes, ketones and esters.

Shipping regulations: (Rail, Air) Flammable Solid and Dangerous When Wet labels. Not acceptable passenger.

lithium bromide LiBr .

Properties: White cubic deliquescent crystals, or as a white to pinkish white granular powder; odorless; sharp, bitter taste. Sp. gr. 3.464; m.p. 547°C; b.p. 1265°C; very soluble in water, alcohol, and ether. Slightly soluble in pyridine; soluble in methanol, acetone, glycol. A hot concentrated solution dissolves cellulose. Forms addition compounds with ammonia and amines. Forms double salts with CuBr_2 , HgBr_2 , HgI_2 , $\text{Hg}(\text{CN})_2$, and SrBr_2 . Greatly depresses vapor pressure over its solutions. Low toxicity.

Derivation: Reaction of hydrobromic acid with lithium carbonate.

Grades: 53% (min) LiBr brine; solid; single crystals.

Containers: Glass jars; bags; brine in steel drums.

Uses: Pharmaceuticals; air conditioning; humectant; drying agent; batteries; low temperature heat-exchange medium; medicine (sedative).

lithium butyl. See butyllithium.

lithium carbide Li_2C_2 . Crystalline white powder; sp. gr. 1.65 (18°C); decomposes in water; soluble in acid, with evolution of acetylene.

Hazard: Fire risk in contact with acids.

lithium carbonate Li_2CO_3 .

Properties: White powder; sp. gr. 2.111; m.p. 735°C; b.p., decomposes at 1200°C. Slightly soluble in water; insoluble in alcohol; soluble in dilute acid.

Derivation: (a) Finely ground ore is roasted with sulfuric acid at 250°C. Lithium sulfate is leached from the mass and converted to the carbonate by precipitation with soda ash. (b) Reaction of lithium oxide with carbon dioxide or ammonium carbonate solution.

Grades: Technical; C.P.

Containers: Fiber drums; barrels; bags.

Hazard: Water solution is strong irritant.

Uses: Ceramics and porcelain glazes; pharmaceuticals; catalyst; other lithium compounds; coating of arc-welding electrodes; nucleonics; luminescent

paints, varnishes and dyes; glass ceramics; aluminum production.

lithium chlorate LiClO_3 .

Properties: Needlelike crystals, deliquescent; sp. gr. 1.119 (18°C); m.p. 128°C; decomposes at 270°C; more soluble in water than any other inorganic salt (313 g per 100 ml water at 18°C); very soluble in alcohol.

Hazard: Dangerous explosion hazard when shocked or combined with organic materials. Strong oxidant. (See "Lith-X").

Uses: Air conditioning; inorganic and organic chemicals; propellants.

Shipping regulations: (Rail, Air) Oxidizer label.

lithium chloride LiCl .

Properties: White deliquescent crystals; sp. gr. 2.068; m.p. 614°C; b.p. 1360°C; very soluble in water, alcohols, ether, pyridine, nitrobenzene. One of the most hygroscopic salts known. Low toxicity, but should not be used as dietary salt substitute.

Derivation: Reaction of lithium ores with chlorides; natural brines.

Grades: Technical, 99% (min) assay; 35-40% brine, inhibited; single crystals.

Containers: Crystals; 25-, 50-, 100-lb paper-lined drums; brine; 75-, 275-, and 500-lb steel drums.

Uses: Air conditioning; welding and soldering flux; dry batteries; heat-exchange media; salt baths; desiccant; production of lithium metal; soft drinks and mineral water to reduce escape of carbon dioxide.

lithium chromate $\text{Li}_2\text{CrO}_4 \cdot 2\text{H}_2\text{O}$.

Properties: Yellow, crystalline deliquescent powder; soluble in water and forms a eutectic at -60°C. Soluble in alcohols.

Hazard: Toxic by ingestion.

Uses: Corrosion inhibitor in alcohol-base antifreezes and water-cooled reactors. Oxidizing agent for organic material, especially in the presence of light; heat-transfer medium.

lithium citrate $\text{Li}_3\text{C}_6\text{H}_5\text{O}_7 \cdot 4\text{H}_2\text{O}$.

Properties: White powder or granules; loses $4\text{H}_2\text{O}$ at 105°C; m.p., decomposes; soluble in water; slightly soluble in alcohol. Low toxicity.

Derivation: Reaction of citric acid with lithium carbonate.

Uses: Beverages; pharmaceuticals; dispersion stabilizer (clay deflocculant).

lithium cobaltite LiCoO_2 . Dark blue powder; insoluble in water. The compound exhibits both the fluxing property of lithium oxide and the adherence-promoting property of cobalt oxide. Low toxicity.

Use: Ceramics.

lithium deuteride LiD .

Properties: Gray crystals; sp. gr. 0.906. Reacts slowly with moist air. Thermally stable to its melting point of 680°C.

Uses: Thermonuclear fusion. See also deuterium.

lithium dichromate $\text{Li}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$.

Properties: Yellowish-red, crystalline powder; sp. gr. 2.34 (30°C); m.p. 130°C; deliquescent; soluble in water; forms eutectic at -70°C.

Uses: Dehumidifying; refrigeration.

lithium ferrosilicon.

Properties: Dark crystalline brittle metallic lumps or powder; evolves flammable gas in contact with moisture. Must be kept cool and dry.

Hazard: Flammable, dangerous fire risk.

Shipping regulations: (Rail, Air) Flammable Solid and Dangerous When Wet labels. Not acceptable passenger.

lithium fluoride LiF .

Properties: Fine white powder; sp. gr. 2.635 (20°C); m.p. 842°C; b.p. 1670°C; slightly soluble in water; does not react with water at red heat; soluble in acids; insoluble in alcohol.

Derivation: Reaction of hydrofluoric acid with lithium carbonate.

Grades: Guaranteed 98% (min) LiF ; C.P.; single pure crystals.

Hazard: Toxic. Strong irritant to eyes and skin.

Tolerance: 2.5 mg per cubic meter of air (as F).

Uses: Welding and soldering flux; ceramics; heat-exchange media; synthetic crystals in infrared and ultraviolet instruments; rocket fuel component; radiation dosimetry. Component of fuel for molten salt reactors; x-ray diffraction.

lithium fluorophosphate $\text{LiF} \cdot \text{Li}_3\text{PO}_4 \cdot \text{H}_2\text{O}$.

Properties: White crystals.

Derivation: Interaction of lithium fluoride and lithium phosphate.

Use: Ceramics.

lithium grease. A grease using a lithium soap of the higher fatty acids as a base. Water-resistant; stable when heated above melting point and cooled again. Used in aircraft and low temperature service. See lithium stearate; lubricating grease. Lithium hydroxystearate from hydrogenated castor oil is also widely used.

lithium hydride LiH .

Properties: White, translucent, crystalline mass or powder. Commercial product is light bluish-gray due to minute amount of colloiddally dispersed lithium. Sp. gr. (20°C) 0.82; m.p. 680°C; decomposition pressure nil at 25°C, 0.7 mm at 500°C, 760 mm at approx. 850°C. Decomposed by water, forming hydrogen and lithium hydroxide; insoluble in benzene and toluene; soluble in ether.

Derivation: Reaction of molten lithium with hydrogen.

Grades: 93-95%, based on hydrogen evolution.

Containers: Cans; cases; drums.

Hazard: Flammable, dangerous fire risk; ignites spontaneously in moist air. Use dry chemical to extinguish. Tolerance, 0.025 mg per cubic meter of air. (See "Lith-X").

small trees, e.g., ammonium

for 2-chloro-4,6-bis(ethyl-
 $(\text{NHC}_2\text{H}_5)_2$.

m.p. 225°C. Insoluble in
 organic solvents. Combust-

ic by ingestion and inhala-
 tion of membranes.

rk for silicone-base insula-
 tes.

electrochemical fluorination
 fluorocarbons by passing an
 a mixture of the organic
 liquid anhydrous hydrogen
 re hydrogen and the desired

lation in which no appreci-
 apor occurs, i.e., the vapor
 in the still is completely
 e receiver and does not un-
 tion due to partial conden-
 evously condensed vapor.

rotein, single-cell.

tion of metal or earthy
 below the melting point.
 metallurgy and ceramic fir-
 ure are essential, decrease
 cal factor. (see Rittinger's
 strength, conductivity, and

for ethoxylated fatty and
 d in cosmetics, textile in-
 agricultural emulsifiers,
 tical intermediates.

industrial grade alcohol
 oxylylate sulfates. Used in
 ymerization, and textile
 principally ammonium,
 diethanolamine lauryl sul-
 fate, sodium 2-ethylhexyl
 ethoxylate sulfate. See

for a group of speciality
 merization. They include
 acrylate, hydroxyethyl
 and diethyl maleates, and

a cosmetic grade of fatty
 alcohol ethoxylate sul-
 ximately the same mate-
 and also diethanolamine
 sulfate, and ammonium

"**Siponate.**"⁵⁴² Trademark for purified alkylarylsul-
 fonates, including sodium dodecyl benzene sulfo-
 nate (branched or linear), and sodium lauroyl
 monoglyceride sulfate.

SIPP. Abbreviation for sodium iron pyrophos-
 phate.

sisal.

Properties: Hard, strong, light yellow to reddish
 fibers obtained from the leaves of *Agave sisilana*.
 Combustible; not self-extinguishing. Strength, 4.5
 grams per denier; fineness ranges from 300 to 500
 denier.

Source: Africa; Haiti; Bahama; Indonesia.

Hazard: Moderate, by inhalation. Dust is flammable.
 May ignite spontaneously when wet.

Uses: Twine; sacking; upholstery; life preservers;
 mattress liners; floor covering.

"**Sitol.**"²⁸ Trademark for an oxidizing agent in flake
 form used in discharge printing.

beta-sitosterol $\text{C}_{29}\text{H}_{50}\text{O}$. 22,23-Dihydrostigmasterol.
 Properties: Waxy white solid; almost odorless and
 tasteless; insoluble in water, soluble in benzene,
 chloroform, carbon disulfide and ether. Can be
 crystallized from ether as anhydrous needles, or
 from aqueous alcohol as leaflets with one molecule
 of water.

Derivation: Soybeans; tall oil.

Uses: Biochemical research; anticholesteremic. See
 also cholesterol.

"**Sixide.**"³¹⁹ Trademark for insecticidal preparations
 containing benzene hexachloride.

size oil. See throwing oil.

sizing compound. (1) A material such as starch, gela-
 tin, casein, gums, oils, waxes, asphalt emulsions,
 silicones, rosin, and water-soluble polymers applied
 to yarns, fabrics, paper, leather and other products
 to improve or increase their stiffness, strength,
 smoothness or weight. (2) A material used to modify
 the cooked starch solutions applied to warp ends
 prior to weaving. See also slashing compound.

"**Skamex.**"²⁸ Trademark for a fluorocarbon plastic
 used as a metallurgical additive for the beneficiation
 of molten metal. Cakes and slugs of it are specifi-
 cally designed for immersion in hot metal for
 removal of excessive quantities of dissolved hydro-
 gen. Other forms are added to molds during casting
 to create a protective atmosphere against the effects
 of absorbed oxygen. Can be used for ferrous and
 nonferrous metals.

Containers: Powder, pellets, cakes and slugs; 50-lb
 drums. Mold wash: 100-lb 44% concentrate, 25-gal
 drums.

skatole (3-methylindole) $\text{C}_9\text{H}_9\text{N}$.

Properties: White crystalline substance, browning
 upon aging; fecal odor. M.p. 93° to 95°C; b.p.
 265°C. Soluble in hot water, alcohol, benzene.

Gives violet color in potassium ferrocyanide and
 sulfuric acid.

Derivation: Feces; African civet cat; *Celtis reticu-*
losa, a Javanese tree.

Use: Perfumery (fixative); artificial civet.

"**Skellysolves.**"⁴⁰⁹ Trademark for straight-run ali-
 phatic naphthas having various boiling ranges, spe-
 cific gravities, evaporation rates and other proper-
 ties, which make them suitable for a number of
 industrial uses.

Hazard: Flammable; dangerous fire risk.

Skraup synthesis. Synthesis of quinoline or its de-
 rivatives by heating aniline or an aniline derivative,
 glycerol and nitrobenzene in the presence of sulfuric
 acid.

"**Skydrol.**"⁵⁸ Trademark for a series of fire-resistant
 aircraft hydraulic fluids.

500-A. Used for hydraulic systems in turbo jet and
 turbo prop aircraft, which must operate at -54°C.
 7000. Used in aircraft cabin superchargers, expan-
 sion turbines for air-conditioning systems and the
 aircraft hydraulic system itself.

slack. (1) Descriptive of a soft paraffin wax result-
 ing from incomplete pressing of the settlings from the
 petroleum distillate. Though it has some applica-
 tions in this form, it is actually an intermediate
 product between the liquid distillate and the scale
 wax made by expressing more of the oil. See also
 scale (2).

(2) Specifically, to react calcium oxide (lime) with
 water to form calcium hydroxide (slacked or hy-
 drated lime); the reaction is $\text{CaO} + \text{H}_2\text{O} \longrightarrow$
 $\text{Ca(OH)}_2 + \text{heat}$. The alternate spelling "slake" has
 the same meaning.

slaframine (1-acetoxy-8-aminooctahydroindoli-
 zine). An alkaloid derived from a fungus that infests
 clover. It is under research development for use as
 an agent in retarding cystic fibrosis.

slag (dross, cinder). (1) Fused agglomerate (usually
 high in silicates) which separates in metal smelting
 and floats on the surface of molten metal. Formed
 by combination of flux with gangue of ore, ash of
 fuel, and perhaps furnace lining. Slag is often the
 medium by means of which impurities may be sepa-
 rated from metal.

(2) The residue or ash from coal gasification
 processes; it may run as high as 40% depending on
 the rank of coal used.

Uses: Railroad ballast; highway construction; ce-
 ment and concrete aggregate; raw material for Port-
 land cement, mineral wool and cinder block.

slake. See slack.

slaked lime. See calcium hydroxide; lime, hydrated.

slashing compound. A textile sizing material applied
 to cotton or rayon warp ends by a special machine
 (slasher).

" Fate and Exposure Data "

Howard, P. 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume III, Pesticides. Chelsea, MI: Lewis Publishers. pgs. 11-23, 90-109, 267-277, 385-427.

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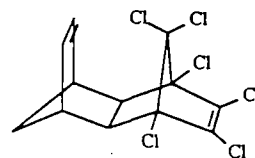
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Aldrin

SUBSTANCE IDENTIFICATION

Synonyms: (1 α ,4 α ,4a β ,5 α ,8a β)-1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonaphthalene

Structure:



CAS Registry Number: 309-00-2

Molecular Formula: C₁₂H₈Cl₆

Wiswesser Line Notation:

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point:

Melting Point: 104 °C

Molecular Weight: 364.93

Dissociation Constants:

Log Octanol/Water Partition Coefficient: 6.5 [11]

Water Solubility: 0.02 mg/L at 20 °C [72]

Vapor Pressure: 3.75 x 10⁻⁵ mm Hg at 20 °C [72]

Henry's Law Constant: 0.496 x 10⁻³ atm-m³/mole [79]

Aldrin

ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Summary: Aldrin is no longer produced or used in the United States and any past releases have probably been converted to dieldrin. Aldrin residues in soil and plants will volatilize from soil surfaces or be slowly transformed to dieldrin in soil. Biodegradation is expected to be slow and aldrin is not expected to leach into most ground waters. Aldrin was classified as moderately persistent meaning its half-life in soil ranged from 20-100 days. Aldrin-residues in water will volatilize from the water surface and photooxidation is expected to be significant. Photolysis has been observed in water, although the absorption characteristics of aldrin indicate it should not undergo extensive direct photolysis in the environment. Bioconcentration will be significant. Adsorption to sediments will be significant and biodegradation is expected to be slow. Vapor phase aldrin residues in the atmosphere are expected to react with photochemically generated hydroxyl radicals with an estimated half-life of 35.46 min. Aldrin in the atmosphere is expected to be adsorbed to particulate matter and no rate can be estimated for the reaction of adsorbed aldrin with hydroxyl radicals. Direct photolysis may also occur, in spite of the low absorption of aldrin at >290 nm. Photolysis, however, is expected to be a slow process relative to reaction with hydroxyl radicals. Due to the cessation of aldrin manufacture and use in the USA, exposure of humans in the USA to the chemical is expected to be low.

Natural Sources: Aldrin is not known to occur as a natural product.

Artificial Sources: Aldrin is an insecticide formerly used against termites and soil-dwelling pests such as ants [83], wireworms, whitegrubs, etc [28]. Aldrin in the environment has resulted from these insecticidal uses. The manufacture and use of aldrin has been discontinued in the United States [53]. Based upon monitoring data, mean loadings of aldrin in kg/day are coal mining - 0.0081, foundries - 0.019 and nonferrous metals manufacturing - 0.0016 [76]. Loading of aldrin in kg/yr to Lake Ontario by Niagara River unfiltered water were: 1980 - <83 , 1981 - <79 , 1982 - <79 [39].

Terrestrial Fate: Aldrin was applied at 1.5 kg ai/ha to flooded soil. After 30, 90, 120, 240, and 270 days, 44.2%, 55.4%, 74.13%, 88.07%, and 100% of the aldrin had dissipated from the soil [70]. Aldrin applied

Aldrin

at 20 lb/6" acre to muck and loam had respective half-lives of 3.75 and 2.40 months for the first half-year and 13.0 and 9.7 months for the following three years [44]. Three and one-half years following the application to a Miami silt loam of 20 and 200 lb aldrin/6" acre, 1.12% and 2.55%, respectively, of the calculated initial amount of aldrin remained [44]. Aldrin was applied 20 lb/6" acre to Miami silt loam and at 100 lb/6" acre to Plainfield sand [44]. After incubation for 56 days at 6, 26, and 46 °C, 83.8%, 55.7% and 13.7% of the initial amount of recoverable aldrin remained on the Miami silt loam and 63%, 38%, and 10.2% remained on the Plainfield sand, respectively [44]. After 2 months incubation with upland soil (80% water saturated) at 30 °C, 44%, 58%, and 33% of about 15 ppm of aldrin applied remained in the Maahas, Luisiana, and Casiguran soils, respectively. Under flooded conditions, 65%, 81%, 74%, and 64% remained in the Pila, Maahas, Luisiana and Casiguran soils, respectively [6]. Soils were treated with aldrin at 5 lb/acre from 1958-62. Dieldrin was formed from aldrin in the soil and constituted 50 and 90% of the aldrin plus dieldrin residues recovered in 1959 and 1963, respectively [42]. Soils from AR, FL, HI, MD, MT, OR, and SC were treated with 10 mL of 0.5% aqueous aldrin emulsion/10 g soil. The preparations were placed randomly around a test site in the Harrison Experimental Forest in southern Mississippi. In all preparations except the Hawaiian soil, the percent degradation in the upper 0.5 inch layer (36-72%) was greater than in the lower layer (unspecified depth) (11-33%). In the Hawaiian soil samples, degradation in the lower layer was 63% and in the upper layer was 49% [5]. Aldrin was converted into dieldrin in these studies [5]. When aldrin was applied to agricultural soils in Germany, Spain, England and the United States, significant amounts of dieldrin derived from the applied aldrin were detected in the soils within 6 months of aldrin application [80]. Aldrin was classified as moderately persistent in soil with a half-life in the range 20-100 days [82].

Aquatic Fate: A river die-away test was conducted in capped bottles with aldrin in raw water from the Little Miami River in Ohio. The river receives domestic and industrial wastes and farm runoff. After 2, 4, and 8 weeks, 20, 60, and 80% of the initial amount of aldrin had degraded [15]. Volatilization from water is expected to be significant and will occur at a rate directly proportional to the rapidity of wind and current velocity and inversely proportional to the depth of the water body.

Aldrin

Photooxidation is expected to be significant. Biodegradation is expected to be slow. Bioconcentration and adsorption to sediments are expected to be significant.

Atmospheric Fate: The half-life for the reaction of vapor phase aldrin with photochemically generated hydroxyl radicals in the atmosphere was estimated to be 35.46 min [21]. Slow photolysis of aldrin vapor (60% in one week vs 16% in a dark control) was observed [10]. This is expected due to the weak absorption of aldrin above 290 nm [23]. Direct photolysis, therefore, is not expected to be significant compared to reaction with hydroxyl radicals.

Biodegradation: In a 5-day biodegradation tests, no biodegradation of aldrin at 5 and 10 mg/L was observed through the third subculture of a mixed culture inoculum from sewage [73]. Activated sludge biodegraded 1.5% of the initial aldrin in 5 days [19]. Aldrin incubated for 30 days in a water surface film collected off of Hawaii was degraded by 8.1% to the diol [62]. A pure culture of the marine alga, *Dunaliella* sp, degraded 23.3% of the initial aldrin to dieldrin and 5.2% to the diol [62]. A pure culture of *Aerobacter aerogenes* degraded 36-46% of the initial amount of aldrin in 24 hours [52]. Aldrin was classified as refractory to biodegradation [59,74]. The degradation half-life of aldrin in a sandy loam soil incubated in the dark ranged 43-63 days with an avg of 53 days [51]. When incubated with mixed anaerobic population, 87% aldrin degraded to two dechlorinated products in 4 days [49].

Abiotic Degradation: Treatment of saturated aldrin vapor (5000 ug) with a sunlamp for 45 hours resulted in 14-34% degradation (based on the amount of aldrin recoverable from the reactor walls) [10]. Dieldrin (50-60 ug) and photoaldrin (20-30 ug) were the photoproducts. Irradiation of 1 ug of aldrin vapor with the sunlamp for 168 hours resulted in 60% degradation compared to 16% degradation in a dark control [10]. Dieldrin (0.63 ug) was the primary photoproduct and photoaldrin (0.02 ug) and photodieldrin (0.02 ug) were also detected [10]. A photolysis half-life of 1.1 day was determined for 0.33 ppb aldrin in San Francisco Bay water exposed to sunlight, although insufficient detail concerning the experimental conditions is available to conclude that this result was due solely to direct photolysis [4]. Exposure of an aldrin film to sunlight for 1 month resulted in a mixture containing 2.6% unchanged aldrin and

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9.6% photoaldrin, 4.1% dieldrin, 24.1% photodieldrin and 59.7% of an unidentified product [66]. Photolysis half-lives of aldrin thin films of thickness 0.67, 3.3 and 6.7 $\mu\text{g}/\text{cm}^2$ irradiated at >300 nm were 4.7, 8.3, and 11 days, respectively [7]. Solid aldrin adsorbed on silica gel irradiated at >290 nm for 6 days was 11% mineralized [37]. A 0.07 M aqueous solution of aldrin in the presence of constituents present in a natural water was 25% photooxidized to dieldrin in 36 hrs at a max wavelength of less than 220 nm [67]. Rotenone, xanthone and anthraquinone act as sensitizers to accelerate photolysis of aldrin [8]. Irradiation of aldrin in 0.05 M hydrogen peroxide for 12 hr at >290 nm reduced the aldrin concentration by 79.5% compared to a dark control in which the aldrin concentration decreased by 32.9% [13]. Photoaldrin, dieldrin, and one unidentified product were isolated from the 0.05 M hydrogen peroxide solution [13]. The estimated hydrolysis half-life at pH 7 is 760 days [16]. Therefore, hydrolysis will not be important.

Bioconcentration: The bioconcentration factor of aldrin in molluscs is 4571 [29], in the golden orfe is 3890, [18], in an unspecified fish is 10,715 [20] and in the alga, *Chlorella fusca*, is 12,260 [22]. Bioconcentration of aldrin is expected to be significant.

Soil Adsorption/Mobility: Aldrin was applied to silty soil at 1.5 kg/ha as a surface spray. Following one simulated rainfall, 5.2% of the aldrin was lost in runoff [63]. Aldrin was immobile in columns containing Hagerstown silty clay loam or Lakeland sandy loam subirrigated for 3 days [26]. Aldrin was applied to the upper 5 inches of a silt loam soil [43]. The percent distribution of aldrin after 10 years in nondisked soil was 0-2" - 11%, 2-4" - 33%, 4-6" - 33%, and 6-9" - 23% and in disked (for one summer only) soil was 0-2" - 13%, 2-4" - 29%, 4-6" - 29%, and 6-9" - 29% [43]. Aldrin in soil was quantified 5, 6, 4, and 3 months following its application at 2.9, 3.0, 3.0; and 3.0 kg/ha to soils used for growing maize in Germany, England, Spain, and the United States, respectively [80]. For soil depths of 0-10 cm, 10-20 cm, 20-40 cm, and 40-60 cm, respective residue levels in ppm (% total aldrin extractable) were: Germany - 0.78 ppm (78%), 0.18 ppm (18%), 0.03 ppm (3%), and <0.01 ppm ($<1\%$); England - 1.30 ppm (ca 100%), <0.01 ppm ($<1\%$) at all other levels; Spain - 0.83 ppm (96.5%), 0.02 ppm (2.3%), 0.01 ppm (1.2%) and <0.01 ppm ($<1\%$); US - 0.50 ppm (98%), 0.01 ppm (1.96%), <0.01 ppm ($<1\%$) at all other levels [80]. Aldrin in soil was quantified

Aldrin

5 months following application at 2.9 kg/ha to soils used for growing wheat in Germany and quantified 4 months following application at 3.2 kg/ha for wheat growing soils in England [80]. For soil depths of 0-10 cm, 10-20 cm, 20-40 cm, and 40-60 cm, respective residue levels in ppm (% total aldrin residues) were: Germany - 1.09 ppm (66.9%), 0.45 ppm (27.6%), 0.09 ppm (5.5%), <0.01 ppm (<1%); England - 2.00 ppm (ca 100%), <0.01 ppm (<1%) at all other levels [80]. A leaching index of 1 (<10 cm leaching through soil column with 150 cm annual rainfall) was assigned to aldrin [17]. Experimentally determined log soil sorption coefficients (Koc) for aldrin ranged from 2.61-5.36 [51,68]. Soil sorption coefficients of these magnitudes suggest that aldrin will not be mobile in soil [32]. Minimal leaching to ground water is expected from these results.

Volatilization from Water/Soil: SOIL: Aldrin was applied at 4 ppm to wet and dry quartz and Plainfield sands. Analysis of air passed over the sand at 1 l/min windspeed for 6 hrs at 22 °C and 38% relative humidity revealed no volatilization of aldrin from the dry Plainfield sand and only a trace from the dry quartz sand (<0.50% of initial aldrin). Four percent and 2.19% of the initial aldrin volatilized from wet quartz and Plainfield sands, respectively, at the same relative humidity. At 100% relative humidity, 1.28% and 6.16% of the aldrin volatilized from dry Plainfield and quartz sands, respectively, and 4.52% and 7.33% of the aldrin volatilized from the wet Plainfield and quartz sands, respectively [27]. Following passage of air at 1 l/min windspeed at 22 °C and 100% relative humidity over quartz sand and Miami silt loam treated with 4 ppm aldrin, 37.9% and 16.3%, respectively of the initial aldrin were recovered in the vapor phase, and 55.3% and 79.7% of the applied aldrin remained in the respective soils [27]. Volatilization rates of aldrin from sand, loam, and humus were 1.08%, 0.21% and 0.8%/ml evaporated water after the first hour and 0.59%, 0.18%, and 0.09%/ml evaporated water in the second hour, respectively [33]. Aldrin was assigned a vaporization index of 1 (<0.1 kg/ha/yr) for volatilization from soil [17]. WATER: After 20 hr at 26.5 °C, 93% of the aldrin initially present (24 ppb), had codistilled with water [31]. Half-lives for the volatilization of aldrin from pure water and waters of the San Francisco Bay, the American River and the Sacramento River are 0.38 hr, 0.59 hr, 0.60 hr, and 0.60 hr, respectively [4]. The volatilization rate of aldrin from water was 16.3%/ml evaporated water after one hour and 6.03%/ml evaporated

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water in the second hour [33]. The estimated volatilization half-life of aldrin from 1 m deep water at 25 °C is 7.7 days [46]. Using a Henry's Law constant of 0.496×10^{-3} atm-m³/mole [72], the half-lives for the volatilization of aldrin from model streams, rivers and lakes are estimated [45] under the assumption that the wind velocity in all the cases were 3 m/s, the current velocities of the streams, rivers and lakes are 2.1, and 0.01 m/s, respectively and the depths of the streams and rivers were 1 m and lakes are 50 m. The estimated half-lives were 5.5 hr, 8.9 hr, and 38 days for the streams, rivers and lakes, respectively. These estimated half-lives are derived without consideration to adsorption. In natural waters where aldrin will be adsorbed considerably by suspended matter and sediment, the volatilization half-lives will be longer.

Water Concentrations: DRINKING WATER: United States (unspecified location) - 5.4 ug/L. The Hague, Netherlands - 0.01 ug/L, Ottawa, Canada - Tap water, 0.7 ug/L [38]. Aldrin was detected but not quantified in USA drinking water from unspecified locations [35,36]. SURFACE WATER: Major USA rivers - 100 sites, max concn 0.085 ug/L [17]. Niagara-on-the-Lake, 1980-82, 75 samples, 1% pos, <0.1 ng/L avg [39]. New Jersey - 604 samples, 23.5% pos, 0.6 ppb max [60]. Ohio River (at different mile point) - 11 samples, 9% pos, <0.1 ug/L max; 12 samples, 8% pos, <0.1 ug/L max; 21 samples, 57% pos, 2.0 ug/L max; 11 samples, 54.5% pos, 1.3 ug/L max; 11 samples, 36.3% pos, 0.5 ug/L max; 11 samples, 18.2% pos, 0.5 ug/L max [58]. Inner Harbor Navigation Canal, Lake Pontchartrain, LA - Ebb tide: 0.3 ppt (1.5 m), Flood Tide: 5.6 ppt (1.5 m) and 2.6 ppt (10 m) [50]. Several US surface waters - 7891 samples, 40.0% pos, 0.001 ug/L median [71]. GROUND WATER: New Jersey - 1076 samples, 26% pos, 1.2 ppb max [60]. Leachate from an inactive industrial disposal site at Love Canal, Niagara Falls, NY following equalization and sand filtration- 23 ug/L [77]. Leachate from an unspecified industrial landfill- 0.023 mg/L [3]. RAIN/SNOW: Unspecified US urban location - 7 ng/m³ (rain/snow) [55]. Unspecified US rural location - 0.5-3 ng/m³ (rain/snow) [55]. Aldrin was detected but not quantified in snow samples collected in Finland and at the North Pole [30].

Effluent Concentrations: Aldrin residues in treated wastewater effluents from a variety of industries were as follows: coal mining - 47 samples, 4.3% pos, 2.2 ppb avg; Foundries - 10 samples, 100% pos, 5-10 ppb, 5.5

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ppb avg; nonferrous metals manufacturing - ND-0.5 ppb, 0.2 ppb avg [76]. Unspecified industrial effluents - 677 samples, 3.1% pos, <0.010 ug/L median [71]. Urban runoff samples from Washington, DC-20% pos and concn range 0.0027-0.1 ug/L [9]. Flint, MI - municipal plant effluent, 0.04-0.06 ppb [34]. Owosso, MI - municipal plant effluent, 0.22 ppb [34].

Sediment/Soil Concentrations: SEDIMENT: Niagara-on-the-lake suspended sediments, 1979-81, 70 samples, 7% pos, 2 ng/g avg [39]. Unspecified US sediments - 2,048 samples, 33.0% pos, 0.1 ug/kg dry weight median [71]. Detected but not quantified in sediments from the Puget Sound, WA [47]. Detected in 5% of Hamilton Harbour sediments collected in 1982 at a median concn less than 1 ug/kg and a max concn 1 ug/kg [64]. SOIL: Nebraska soils - 1969, 106 sites, 1% pos, ND-0.01 ppm, <0.01 ppm avg; 1970, 106 samples, 3.77% pos, 0.01 ppm max and min, <0.01 ppm avg; 1971, 106 samples, 0.90% pos, ND-0.02 ppm, <0.01 ppm avg; 1973, 101 samples, 2% pos, 0.01-0.06 ppm, <0.01 ppm avg [2]. Ontario, Canada - 1976, agricultural soils, ND-0.06 ppm [54].

Atmospheric Concentrations: Aldrin was detected within 800 m of two formulation plants in Arkansas in 1970 and 1971 [40]. Residues were: 1970 - 66 samples, 24% pos, 0.6-1.4 ng/m³, 0.9 ng/m³ avg; 1971 - 60 samples, 10% pos, 0.4-6.3 ng/m³, 1.5 ng/m³ avg [40]. One of 94 air samples taken in Iowa City, Iowa during 1967-68 was positive for aldrin and contained 8.0 ng/m³ [40]. Air samples taken in Miami were 14.3% pos, and ranged from ND-1.1 ng/m³ with a 0.2 ng/m³ avg and in the Everglades National Park were 7.1% pos, and ranged from ND-0.5 ng/m³ with a 0.04 ng/m³ avg [40]. The aldrin concentration in the air of a South Florida Formulation plant was 437.0 ng/m³ in 1974 [40]. Aldrin concentrations in the air above a hazardous liquid waste impoundment at an unspecified location ranged from ND-380 ng/m³ [25]. Unspecified US urban location - 1-10 ng/m³ (vapor/particulate) [55]. Unspecified US rural location - 0.1-1 ng/m³ (vapor/particulate) [55]. Indoor and outdoor air of nine households (7 of 9 were known to have been treated for termites) in an urban-suburban area of the southeastern U.S. during 1985 - detected in indoor and outdoor air of 4 households [41].

Food Survey Values: Average dietary intake during 1971-1976 - 0.5 ng/kg body weight/day [14]. Year-% positive composites (daily intake in ug) for aldrin: 1971 - not found, 1972 - 0.2 (Trace), 1973 - 0.3 (0.006),

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1974 - 0.3 (0.006), 1975 - 0.4 (0.2), 1976 - not found [14]. Cheese - domestic 784 samples, 0.7% pos, 0.004 ppm avg; imported 5471 samples, 0.08% pos, <0.0001 ppm avg [14]. Red meat - 15,200 samples (1972-1976), 0.8% pos, 0.0007 ppm avg, fat basis [14]. Poultry (1972-1976), 0.7% pos, 0.0005 ppm avg, fat basis [14]. Large fruits - domestic 3281 samples, 0.8% pos, 0.0002 ppm avg; imported 1048 samples, 0.3% pos, <0.0001 ppm avg [14]. Small fruits - domestic 1445 samples, 0.3% pos, <0.0001 ppm avg; imported 2119 samples, 0.4% pos, <0.0001 ppm avg [14]. Vine and ear vegetables - domestic 2954 samples, 0.2% pos, <0.0001 ppm avg; imported 4117 samples, 0.3% pos, 0.0001 ppm avg [14]. Root vegetables - domestic 3248 samples, 0.7% pos, 0.0002 ppm avg; imported 609 samples, 0.3% pos, <0.0001 ppm avg [14]. Whole grains - domestic 947 samples, 0.1% pos, <0.0001 ppm avg; imported 85 samples, 1.2% pos, 0.0002 ppm avg [14]. Corn - 280 samples, 0.4% pos, <0.0001 ppm [14]. Cottonseed - 54 samples, 4.3% pos, 0.409 ppm avg [14]. Peanuts and peanut products - 148 samples, 0.7% pos, 0.0005 ppm avg [14]. Aldrin was infrequently found in eggs and egg products, leaf and stem vegetables, and nuts [14]. One August 1973-July 1974 food composite (fruits) contained 0.001 ppm aldrin [48]. These values were determined on foods prior to the cessation of aldrin use.

Plant Concentrations: The mean concn of aldrin in aquatic vascular plants collected from Lake Pajanne, Finland during 1972-1973 was 2 ug/kg \pm 5 ug/kg (dry weight) [78].

Fish/Seafood Concentrations: Fish - domestic 2901 samples, 0.5% pos, 0.0002 ppm avg [14]. Mussel - 1 ppb [65]. Crab - 16 ng/g [65]. Aldrin was detected but not quantified in bottom-dwelling fish taken from the Puget Sound, WA [47]. Aldrin levels ranged 0.012-0.12 mg/kg in whole fish from Ohio River tributaries collected in 1978-1979 [58]. Different fish species from Abu Qir Bay, Idku Lake, and Maryut Lake in Alexandria, Egypt, were assayed for residues of organochlorine insecticides and polychlorinated biphenyls (PCBs). The fish were obtained from commercial fishermen in 1985: Pagellus erythrinus, Sargus vulgaris, Siganus rivulatis, Sphyræna sphyræna, and Trigla herundo from Abu Qir Bay; and Tilapia fish from Idku and Maryut Lakes. Assays for aldrin indicated it was present in low concentrations. The highest value obtained was 19.9 ug/kg in Sargus vulgaris from Abu Qir Bay. Aldrin was present in low and similar amounts (1.1-3.5 ug/kg) in small and

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medium sized *Tilapia nilotica*. Size ranges of *Tilapia zilli* showed variation of 5.7 ug/kg (small) to 13.1 ug/kg (large) in the concentration of aldrin in muscle tissue [56].

Animal Concentrations: Water snakes taken in Louisiana contained ND-0.02 ppm (wet weight) aldrin [69]. Measurements of aldrin levels were made on fresh tissue of 3 whales taken off Chile [61]. Level- 0.028 mg/kg avg in blubber, 0.004 mg/kg avg in liver [61]. Mean concn in game bird muscle from upper Tennessee, U.S. ranged from 0.18 to 0.59 mg/kg [78]. Level in fat of hooded seal from Greenland was 28 mg/kg [78].

Milk Concentrations: Fluid milk - domestic 4638 samples, 0.3% pos, 0.0002 ppm aldrin avg [14]. Human milk collected 3-6 days after parturition from mothers at 4 hospitals in Quebec, Canada - 154 samples, 0.041 ± 0.068 ppm avg [12]. It was detected in human milk at an avg concn 0.041 ± 0.068 ppm [12].

Other Environmental Concentrations: Chilean animal feed - avg concn 0.023 ppm [57].

Probable Routes of Human Exposure: The biotransformation factors for aldrin from beef, milk and vegetable are 0.085, 0.024 and 0.021, respectively [75]. Cessation of aldrin production and use is expected to eventually eliminate human exposure to the insecticide in the USA but will result in dieldrin exposure. Individuals residing in countries where aldrin is still used are expected to be exposed to the compound by ingestion of contaminated food and drinking water.

Average Daily Intake: FOOD: 0.053 ug [14]. The daily intake in U.S. population of all age groups (6 months to 65 yr-old) during 1982-1984 was less than 0.1 ng/kg body wt/day [24].

Occupational Exposure: In occupational situations (industrial production, agricultural and other public health use), the route of intake will be percutaneous. The intake through skin exposure will be much greater than inhalation exposure.

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Body Burdens: Aldrin was identified but not quantified in human adipose tissue during 1970-1975 [1]. Human adipose tissue collected in 1984 from 6 Canadian municipalities - none detected at a minimum detection limit of 1.2 ug/kg [81].

REFERENCES

1. Anderson HA; Environ Health Persp 60: 127-31 (1985)
2. Ball HJ; J Environ Sci Health B18: 735-44 (1983)
3. Brown KW, Donnelly KC; Haz Wast Haz Mater 5: 1-30 (1988)
4. Callahan MA et al; Water Related Environ Fate of 129 Priority Pollut pp 21-1 to 21-13 USEPA-440/4-79-029a (1979)
5. Carter FL, Stringer CA; Pest Cont 39: 13-22 (1971)
6. Castro TF, Yoshida T; J Agr Food Chem 19: 1168-70 (1971)
7. Chen Z et al; Ind Eng Chem Prod Res Dev 23: 5-11 (1984)
8. Choudhry GG, Webster GRB; Res Rev 96: 79-136 (1985)
9. Cole RH et al; J Water Pollut Cont Fed 56: 898-908 (1984)
10. Crosby DG, Moilanen KW; Arch Environ Contam Toxicol 2: 62-74 (1974)
11. De Bruijn et al; Environ Toxicol Chem 8: 499-512 (1989)
12. Dillion JC et al; Food Cosmet Toxicol 19: 437-42 (1981)
13. Draper WM, Crosby DG; J Agric Food Chem 32: 231-7 (1984)
14. Duggan RE et al; Pest Res Levels in Foods in US from July 1, 1969 to June 30, 1976 FDA and AOAC (1983)
15. Eichelberger JW, Lichtenberg JJ; Environ Sci Technol 5: 541-4 (1971)
16. Ellington JJ et al; Measurement of Hydrolysis Rate Constants for Evaluation of Hazardous Waste Land Disposal: vol 3. Data on 70 Chemicals USEPA/600/3-88/028 available through NTIS PB88-234042 (1988)
17. Faust SD; Adv Environ Sci Technol 8: 317-65 (1977)
18. Freitag D et al; Ecotoxicol Environ Safety 6: 60-81 (1982)
19. Freitag D et al; Chemosphere 14: 1589-1616 (1985)
20. Garten CT, Trabalka JR; Environ Sci Technol 17: 590-5 (1983)
21. GEMS; Graphical Exposure Modeling System Fate of Atmospheric Pollut data base Office of Toxic Substances USEPA (1986)
22. Geyer H et al; Chemosphere 13: 269-84 (1984)
23. Gore RC et al; J Assoc Off Anal Chem 54: 1040-82 (1971)
24. Gunderson EL; J Assoc Off Anal Chem 71: 1200-9 (1988)
25. Guzewich DC et al; Air Pollut Cont Assoc 76th Ann Mtg Atlanta, GA pp 1-14 (1983)
26. Harris CI; J Agric Food Chem 17: 80-2 (1969)
27. Harris CR, Lichtenstein EP; J Econ Entomol 54: 1038-45 (1961)
28. Hartley D et al; The Agrochemicals Handbook. Surry, UK: Unwin Bros Ltd (1985)
29. Hawker DW, Connell DW; Ecotoxicol Environ Safety 11: 184-97 (1986)

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30. Herve S; Chemosphere 14: 1741-8 (1985)
31. Huang JC; Eng Bull Purdue Univ Eng Ext Series p 449-57 (1970)
32. Kenaga EE; Ecotox Env Safety 4: 26-38 (1980)
33. Kilzer L et al; Chemosphere 10: 751-61 (1979)
34. Konasewich D et al; Status Report on Org and Heavy Metal Contaminants in the Lake Erie, Michigan, Huron and Superior Basins. Great Lakes Water Quality Board (1978)
35. Kool HJ et al; CRC Crit Rev Environ Cont 12: 307-57 (1982)
36. Kopfler FC et al; Adv Environ Sci Technol 8: 419-33 (1977)
37. Korte F et al; Chemosphere 1: 79-102 (1978)
38. Kraybill HF; NY Acad Sci Ann 298: 80-9 (1977)
39. Kuntz KW; Toxic Contam in the Niagara River, 1975-82 Burlington, Ontario Tech Bull No.134 (1984)
40. Lewis RG, Lee RE Jr; pp 5-51 in Air Pollut From Pesticides and Agricultural Processes, Lee RE Jr ed CRC Press Cleveland, OH pp 5-51 (1976)
41. Lewis RG et al; APCA Annu Meet 79th, Minneapolis, MN June 22-27 (1986)
42. Lichtenstein EP et al; J Agric Food Chem 18: 100-6 (1970)
43. Lichtenstein EP et al; J Agric Food Chem 19: 718-21 (1971)
44. Lichtenstein EP, Schulz KR; J Econ Entomol 52: 124-31 (1959)
45. Lyman WJ et al; Handbook of Chem Property Estimation Methods Environ Behavior of Org Compounds McGraw-Hill NY pp 15-21 (1982)
46. Mackay D, Leinonen PJ; Environ Sci Technol 9: 1178-80 (1975)
47. Malins DC et al; Environ Sci Technol 18: 705-13 (1984)
48. Manske DD, Johnson RD; Pest Monit J 10: 134-48 (1977)
49. Maule A et al; Pestic Biochem Physiol 27: 229-36 (1987)
50. McFall JA et al; Chemosphere 14: 1253-65 (1985)
51. McLean JE et al; J Environ Engineer 114: 689-703 (1988)
52. Mendel JL et al; J Assoc Off Anal Chem 50: 897-903 (1967)
53. Merck Index; An Encyclopedia of Chemicals, Drugs and Biologicals 10th ed p 36 (1983)
54. Miles JRW, Harris CR; J Environ Sci Health B13: 199-209 (1978)
55. Miller JM; The Potential Atmospheric Impact of Chemicals Released to the Environment USEPA-560/5-80-001 (1981)
56. Nabawi A et al; Arch Environ Contam Toxicol 16: 689-96 (1987)
57. Ober AG et al; Bull Environ Contam Toxicol 38: 404-8 (1987)
58. Ohio River Valley Sanitation Committee; Assess of Water Qual Conditions Ohio River Mainstem 1978-9 (1980)
59. Okey RW, Bogan RH; J Water Pollut Cont Fed 37: 692-712 (1965)
60. Page WG; Environ Sci Technol 15: 1475-81 (1981)
61. Pantoja S et al; Marine Pollut Bull 16: 255 (1985)
62. Patil KC et al; Environ Sci Technol 6: 629-32 (1972)
63. Pionke HB, Chesters G; J Environ Qual 2: 29-45 (1973)
64. Poulton DJ; J Great Lakes Res 13: 193-201 (1987)
65. Reish DJ et al; J Water Pollut Cont Fed 54: 786-812 (1982)
66. Rosen JD; pp 452-38 in Org Compounds in Aquatic Environ Faust SJ ed, Dekker, NY (1971)

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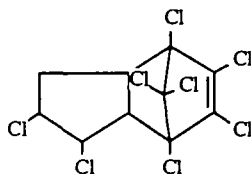
67. Ross RD, Crosby DG; Environ Toxicol Chem 4: 773-8 (1985)
68. Sabljic A; J Agric Food Chem 32: 243-6 (1984)
69. Sabourin TD et al; Bull Environ Contam Toxicol 32: 460-8 (1984)
70. Singh G et al; Ecotoxicol Environ Safety 9: 294-9 (1985)
71. Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)
72. Sunitio LR et al; Rev Environ Contam Toxicol 103: 1-59 (1988)
73. Tabak HH et al; Proc Sym Assoc Off Anal Chem 94th Ann Mtg p 267-328 (1981)
74. Thom NS, Aff AR; Proc R Soc Land B 189: 347-57 (1975)
75. Travis CC, Arms AD; Environ Sci Technol 22: 271-74 (1988)
76. USEPA; Treatability Manual Vol 1 Treatability Data USEPA-600/2-81-011a (1981)
77. Venkataramani ES et al; CRC Crit Rev Environ control 14: 333-76 (1984)
78. Verschuere K; p 168-173 Handbook of Environmental Data on Organic Chemicals, Van Nostrand Reinhold Co, NY (1983)
79. Warner HP et al; Determination of Henry's Law Constants of Selected Priority Pollutants USEPA/600/D-87/229 Available through NTIS PB87-212684 (1987)
80. Weisgerber I et al; J Agric Food Chem 22: 609-12 (1974)
81. Williams DT et al; J Assoc Off Anal Chem 71: 410-14 (1988)
82. Willis GH, McDowell LL; Environ Toxicol Chem 1: 267-79 (1982)
83. Worthing CR; The Pesticide Manual 7th ed Worthing ed p 6 (1983)

Chlordane

SUBSTANCE IDENTIFICATION

Synonyms: 1,2,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methano-1H-indene

Structure:



CAS Registry Number: 57-74-9 (nonstereospecific chlordane); 12789-03-6 (technical); 5103-71-9 (cis- or α -isomer); 5103-74-2 (trans- or β -isomer); 5564-34-7 (γ -isomer)

Molecular Formula: $C_{10}H_6Cl_8$

Wiswesser Line Notation: L C555 A IUTJ AG AG BG DG EG HG IG JG

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point: 175 °C at 2 mm Hg

Melting Point: 107.0-108.8 °C (cis-isomer); 103.0-105.0 °C (trans-isomer); 131 °C γ isomer

Molecular Weight: 409.80

Dissociation Constants:

Log Octanol/Water Partition Coefficient: 5.54 (estimated for pure chlordane) [29]

Water Solubility: 0.1 mg/L at 25 °C (technical chlordane) [136], (solubility of the components of technical chlordane may differ from the solubility of the technical product); 0.056 mg/L at 25 °C (75:25 cis:trans mixture) [110]

Vapor Pressure: 10^{-6} mm Hg at 25 °C
chlordane
for crystalline
[43]; 3.9

Henry's Law Constant: [121]; 1 m³/mole

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Summary: primarily used and greater than 1988, the underground commercial USEPA compound chlordane 3a,4,5,5a-cyclobutane hexahydro persists degradation a mean immobil leaching various ground can volatilized sprayed into soil biodegraded chlordane consists of conditions

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Vapor Pressure: At 25 °C: 4.6×10^{-4} mm Hg (technical) [136]; 9.8×10^{-6} mm Hg (refined technical product) [136]; 2.2×10^{-5} mm Hg (cis-chlordane, supercooled liquid) [43]; 3.0×10^{-6} (cis-chlordane, calculated for crystal) [43]; 2.9×10^{-5} mm Hg (trans-chlordane, supercooled liquid) [43]; 3.9×10^{-6} (trans-chlordane, calculated for crystal) [43]

Henry's Law Constant: 4.85×10^{-5} atm-m³/mole (technical chlordane) [121]; 1.3×10^{-3} atm-m³/mole at 25 °C (γ-chlordane) [9]; 8.6×10^{-4} atm-m³/mole at 25 °C (α-chlordane) [9]

ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Summary: Chlordane has been released in the past into the environment primarily from its application as an insecticide. The amount of chlordane used annually in the U.S. prior to 1983 was estimated in 1985 to be greater than 3.6 million pounds. Between July 1, 1983 and April 14, 1988, the only approved use for chlordane in the U.S. was for underground termite control. As of April 14, 1988, however, all commercial use of chlordane in the U.S. has been canceled by the USEPA. Technical grade chlordane is a mixture of at least 50 compounds; the major constituents of the mixture are cis- and trans-chlordane, heptachlor, cis- and trans-nonachlor, α-, β- and γ-chlordene, 3a,4,5,5a,6-exo-hexachloro-1a,2,3,3a,5a,5b-hexahydro-1,4-methano-1H-cyclobuta(cd)pentalene, and 2,4,4,5,6,6,7,8-octahydro-2,3,3a,4,5,7a-hexahydro-1,4-methano-1H-indene [11]. If released to soil, chlordane may persist for long periods of time. Under field conditions, the mean degradation rate has been observed to range from 4.05-28.33%/yr with a mean half-life of 3.3 years. Chlordane is expected to be generally immobile or only slightly mobile in soil based on field tests, soil column leaching tests and estimated Koc estimation; however, its detection in various ground waters in NJ and elsewhere indicates that movement to ground water can occur. Soil volatility tests have found that chlordane can volatilize significantly from soil surfaces on which it has been sprayed, particularly moist soil surfaces; however, shallow incorporation into soil will greatly restrict volatile losses. Although sufficient biodegradation data are not available, it has been suggested that chlordane is very slowly biotransformed in the environment which is consistent with the long persistence periods observed under field conditions. If released to water, chlordane is not expected to undergo

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significant hydrolysis, oxidation or direct photolysis. The volatilization half-life from a river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec is estimated to be 7.3-7.9 hrs at 23 °C for the γ - and trans-isomers, respectively, and 43 hrs for technical chlordane; the volatilization half-lives from a representative environmental pond, river and lake are estimated to be 18-26, 3.6-5.2 and 14.4-20.6 days, respectively. However, adsorption to sediment significantly attenuates the importance of volatilization. Adsorption to sediment is expected to be a major fate process based on soil adsorption data, estimated Koc values (24,600-15,500), and extensive sediment monitoring data. Bioconcentration is expected to be important based on experimental BCF values which are generally above 3,200. Sensitized photolysis in the water column may be possible. The presence of chlordane in sediment core samples suggests that chlordane may be very persistent in the adsorbed state in the aquatic environment. The observation that 85% of the chlordane originally present in a sealed glass jar under sunlight and artificial light in a river die-away test remained at the end of two weeks and persisted at that level through week 8 of the experiment; this indicates that chlordane will be very persistent in aquatic environments. If released to the atmosphere, it will be expected to be predominantly in the vapor phase. Chlordane will react in the vapor-phase with photochemically produced hydroxyl radicals at an estimated half-life rate of 6.2 hr suggesting that this reaction is the dominant chemical removal process. The detection of chlordane in remote atmospheres (Pacific and Atlantic Oceans; the Arctic) indicates that long range transport occurs. It has been estimated that 96% of the airborne reservoir of chlordane exists in the sorbed state which may explain why its long range transport is possible without chemical transformation. The detection of chlordane in rainwater and its observed dry deposition at various rural locations indicates that physical removal via wet and dry deposition occurs in the environment. Major general population exposure to chlordane can occur through oral consumption of contaminated food and inhalation of contaminated air. Occupational exposure by dermal and inhalation routes related to the use of chlordane as an insecticide may be significant.

Natural Sources: Chlordane is not known to occur as a natural product [65].

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Artificial Sources: Chlordane in the past had been released into the environment primarily from its application as an insecticide. The amount of chlordane used annually in the U.S. prior to 1983 was estimated in 1985 to be greater than 3.6 million pounds [57]. It was applied directly to soil or foliage to control a variety of insect pests [136]. Chlordane may have entered the atmosphere through volatilization from plants, soil or water. Between July 1, 1983 and April 14, 1988, the only approved use for chlordane in the U.S. was for underground termite control [128]. As of April 14, 1988, however, all commercial use of chlordane in the U.S. has been canceled by the USEPA [128].

Terrestrial Fate: Chlordane released to soils may persist for long periods of time [104,110]. One review of chlordane soil persistence literature has reported that the mean degradation rate of chlordane in soil under field conditions has been observed to range from 4.05-28.33%/year [110]; another literature review has reported that the mean half-life of chlordane under field conditions is 3.3 years [104]. Based on field tests, soil column leaching tests and Koc estimations [22,81,82,135], chlordane is expected to be generally immobile or only slightly mobile in soil [122]; however, the detection of chlordane in a number of NJ ground waters and ground waters elsewhere indicates that leaching can occur [30,100,134]. Soil volatility studies have found that chlordane can volatilize significantly from soil surfaces on which it has been sprayed, particularly moist soil surfaces; however, shallow incorporation into soil was found to greatly restrict volatilization losses [61]. Sufficient data are not available to predict the biodegradation rate of chlordane in soil. However, it has been suggested [22] that chlordane is very slowly biotransformed in the environment (similar in nature to dieldrin) which is consistent with the long persistence periods observed under field conditions.

Aquatic Fate: Chlordane released to water is not expected to undergo significant hydrolysis, oxidation, or direct photolysis in water [62,83]. Based on experimentally determined Henry's Law constants [9,121], chlordane (γ - and trans-isomers and technical grade chlordane) can be expected to volatilize significantly from the water column to the atmosphere; the volatilization half-life from a river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec is estimated to be 7.3 and 7.9 hr at 23 °C for the γ - and trans-isomers, respectively, and 43 hr

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for technical chlordane [82] while the volatilization half-lives from a representative environmental pond, river and lake are estimated to be 18-26, 3.6-5.2 and 14.4-20.6 days, respectively [39]. Adsorption to sediment, however, significantly attenuates the importance of volatilization [22]. Adsorption to sediment is expected to be a major fate process in aquatic environments based on soil adsorption data, estimated Koc values (24,600-15,500) [82], and extensive sediment monitoring data. Bioconcentration is also expected to be significant based on experimental BCF values ranging from 400 to 38,000 with most of the BCF values above 3,200 [94,129]. Acetone, benzophenone and rotenone have been found to sensitize the photolysis of chlordane in the laboratory which may suggest that sensitized photolysis in the natural water column is possible [22]. The presence of chlordane in sediment core samples suggests that chlordane may be very persistent in the adsorbed state in the aquatic environment [18]. The observation that 85% of the chlordane originally present in a sealed glass jar under sunlight and artificial light in a river die-away test remained at the end of two weeks and persisted at that level through week 8 of the experiment [36] indicates that chlordane will be very persistent in aquatic environments.

Atmospheric Fate: If chlordane is released to the atmosphere based upon its vapor pressure, it will be expected to be predominantly in the vapor phase [17,43]. Chlordane present in the atmosphere in the vapor-phase will react with photochemically produced hydroxyl radicals at an estimated half-life rate of 6.2 hr [55] suggesting that this reaction is the dominant chemical removal process for vapor-phase chlordane. Since chlordane does not absorb UV light above 280 nm [62], direct photolysis should not occur. The detection of chlordane in the ambient atmosphere of remote locations in the Pacific and Atlantic Oceans and in the Arctic air [8] indicates that long range transport of the chemical occurs. However, it has been estimated that 96% of the airborne reservoir of chlordane exists in the sorbed state [126]. Particulate-phase chlordane may be physically removed from the atmosphere by wet and dry deposition processes. Its detection in rainwater [8] suggests that wet deposition occurs. The dry deposition velocity of chlordane has been observed to be 0.13 cm/sec at various rural locations on the eastern coast of the USA [15].

Biodegradation: Domestic biodegradation subculture was able to degrade heptachlor hydroxy- and isolated from the same source were able to degrade [116]. The solutions, chlordane rate in the least 10 y indicates the die-away rate in a jar under sunlight and persisted possible to and abiotic [36].

Abiotic Degradation: Environmental constants, the rate of singlet oxygen or hexane solvent indicating the rate of Chlordane biodegradation in the presence of susceptible microorganisms. trans-Chlordane exposed to sunlight and rotenone (a photosensitizer) [66]. Benzophenone of cis-chlordane and cis-chlordane. The rate of abiotic photochemical

Chlordane

Biodegradation: Using a static-culture flask-screening procedure (settled domestic wastewater as microbial inoculum), chlordane had 0% biodegradation after 28 days of incubation which included three weekly subcultures [124]. A pure culture of *Nocardiosis* sp. isolated from soil was able to degrade chlordane with dichlorochlordene, oxychlordane, heptachlor, heptachlor-endo-epoxide, chlordene, chlorohydrin, and 3-hydroxy-trans-chlordene produced as metabolites [12]. Microorganisms isolated from petroleum based cutting fluids cultivated on heptachlor were able to rapidly degrade chlordane with 76-83% degradation in 4 hrs [116]. The fungus *Aspergillus niger* was able to use chlordane in nutrient solutions, but not as a sole carbon source [67]. It has been suggested that chlordane is comparable to dieldrin with a very slow biotransformation rate in the environment [22]. The finding of chlordane residues in soil at least 10 years after the last known application of the pesticide [12] indicates that chlordane at best only slowly biodegrades in soil. In a river die-away test, 85% of the chlordane originally present in a sealed glass jar under sunlight and artificial light remained at the end of two weeks and persisted at that level through week 8 of the experiment; it is not possible to estimate the proportion of chlordane decrease due to biotic and abiotic processes since no tests were done with sterilized river water [36].

Abiotic Degradation: Aquatic hydrolysis of chlordane is not an environmentally significant fate process [83]. Based on estimated rate constants, the aquatic oxidation of chlordane in water via alkoxy radicals or singlet oxygen is not environmentally significant [83]. Chlordane (in hexane solvent) does not absorb UV radiation above 280 nm [62] indicating that direct photolysis should not occur in the environment. Chlordane has been shown to undergo photosensitized reactions with the presence of acetone as a photosensitizer; cis-Chlordane is more susceptible to sensitized photolysis than trans-chlordane [22]. cis- and trans-Chlordane experienced 70-80 and 15-20% respective losses when exposed to 4 hrs of sunlight on bean leaves that had been treated with rotenone (a photosensitizer); no loss occurred in the absence of rotenone [66]. Benzophenone and acetone were found to sensitize the photolysis of cis-chlordane at environmentally significant wavelengths with photo-cis-chlordane being formed as the major photoreaction product [41,102]. The rate constant for the vapor-phase reaction of chlordane with photochemically produced hydroxyl radicals has been estimated to be 3.9

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$\times 10^{-11}$ cm³/molecule-sec at 25 °C which corresponds to a half-life of 6.2 hr in an average atmosphere containing $8 \times 10^{+5}$ hydroxyl radicals/cm³ [55]. In a river die-away test, 85% of the chlordane originally present in a sealed glass jar under sunlight and artificial light remained at the end of two weeks and persisted at that level through week 8 of the experiment; it is not possible to estimate the proportion of chlordane decrease due to biotic and abiotic processes since no tests were done with sterilized river water [36].

Bioconcentration: Chlordane BCF of 11,500 and 8,320 were measured for fish in flowing water and static ecosystem tests, respectively [72]. A 24-hr BCF of 10,200 was measured for green algae [60]. A BCF of 38,000 was measured for fathead minnows over a 32-day exposure [129]. BCF values of 6,300-20,000 were determined for juvenile and adult sheepshead minnow over 28-189 day exposures [101]. BCF values of 3,300 and 400 were determined for large mouth bass and clams, respectively, over 106-127 days durations [94]; a 10-day BCF of 7,240 was found for eastern oysters [94]. trans-Chlordane had a 24-hr flow-system BCF of 4,570 in the edible portion of spot fish [114]. A BCF of 5,500 was estimated for redhorse and white suckers [107]. Xenopus laevis (frogs), Lepomis macrochirus (bluegills), and Carassius auratus (goldfish) exposed to 5 ppb exhibited a BCF of 108 at 96 hr, 322 at 24 hr, and 990 at 16 hr, respectively (times are for maximum absorption in a static system) [131]. Hyallolella azteca (scub) exposed to technical chlordane exhibited a whole body BCF of 5200 over a period of 65 days [23].

Soil Adsorption/Mobility: Less than 2% of applied chlordane reached the 15-23 cm depth zone in field tests in British Columbia conducted over a 16 month period with 225 cm of rainfall [135]. Soil column leaching tests using five different soil types (sandy, sandy loams, and silty clay loam) found that in excess of 99% of applied chlordane was retained in the upper 10 cm of soil over an 80 day period [135]. Chlordane absorbs almost completely to sediments in water sediment systems over a period of about six days [98,99]. Based on the log K_{ow} and the water solubility for technical chlordane, the K_{oc} value for chlordane can be estimated to be 24,600 and 15500, respectively, from regression-derived equations [82]; these K_{oc} values indicate that chlordane will be slightly mobile to immobile in soil [122].

Volatilization: Chlordane is a relatively volatile compound. Wind velocity and relative humidity are important factors in determining the volatilization rate. The volatilization rate of chlordane is estimated to be fast in the range of 10-20% per hour. The volatilization rate of chlordane is estimated to be fast in the range of 10-20% per hour. The volatilization rate of chlordane is estimated to be fast in the range of 10-20% per hour.

Water Quality: Chlordane is a persistent organic pollutant. It is found in the water of the Kansas River. It is detected in the water of the Kansas River.

Chlordane

Volatilization from Water/Soil: The Henry's Law constants indicate that volatilization from environmental waters will probably be significant and relatively rapid [9,82,121]. The volatilization half-lives of γ - and α -chlordane from a model river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec can be estimated to be 7.3 hr and 7.9 hr, respectively [82]. Based on measured chlordane to oxygen reaeration ratios at 23 °C [9], the volatilization half-lives of γ - and α -chlordane from a model environmental pond (2 m deep), river (3 m deep) and lake (5 m deep) are estimated to be 18-26, 3.6-5.2 and 14.4-20.6 days, respectively [82]. Based upon the measured Henry's Law constant for technical chlordane [121], the volatilization half-life from a model river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec can be estimated to be 43 hr [82]. Chlordane was found to volatilize significantly from a flask containing natural water. However, when sediment was added to the flask, more than 80% of the chlordane initially in solution was recovered from the sediment after 12 weeks demonstrating that adsorption to sediment can significantly attenuate the importance of volatilization [22]. Volatilization kinetics, however, appear to be faster than absorption kinetics which suggests that the attenuation of the rate of volatilization by adsorption to sediments may not be as significant [11] as would appear from data obtained from laboratory tests [22]. Half-lives of <10 days can be estimated for volatilization from a typical pond and lake using a model which considers both volatilization and adsorption kinetics [39]. Nevertheless, based upon knowledge that the majority of the chlordane probably enters water as runoff from urban and agricultural soils [11] and that monitoring data indicate that sediment concn of chlordane are much higher in the overlying water [18,97], volatilization from surface waters may not be as fast as predicted. In soil volatility studies, 2% of the chlordane sprayed onto a dry fallow soil surface was lost in 50 hr while 50% was lost from a moist soil surface in 60 hr [61]. Dry soil was found to restrict vapor losses of chlordane and other pesticides; shallow incorporation into the soil greatly restricted volatilization losses [61]. Chlordane volatilized quite rapidly from sprayed alfalfa plants with a 95% loss in 21 days [35].

Water Concentrations: DRINKING WATER: Chlordane was qualitatively detected in drinking water from New Orleans, LA and Kansas City, MO and KS [1]. Chlordane (unspecified isomers) was detected at concn of 0.80 and 0.13 ug/L in drinking water from two tanks

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sampled between November 1986 and June 1987 on the New South Wales, Australia, northern coast; one of the tanks also contained oxychlordane at a concn of 0.5 ug/L [5]. Chlordane was found in the drinking water of Pittsburgh, PA in December 1980 at concn ranging from <1.0 to 6,600 ppb [6]. It was found in 22% of 63 drinking water samples from 7 U.S. cities between 1965 and 1967 [113]. Chlordane was found in the drinking water of Chattanooga, TN sampled on March 24, 1976 at concn up to 1,200 ppm [63]. GROUND WATER: Chlordane was detected in 433 of 1076 samples collected in NJ between 1977-1979 with max concn of 0.4 ppb [100]. Chlordane (unspecified isomers) had confirmed detections in Mississippi (1.80 ppb maximum concn - normal agricultural use origin), Indiana (0.04 ppb maximum - point source origin), and Kansas (7.90 ppb maximum - unknown origin) [134]. Chlordane was detected, but not quantified, in 4 out of an unspecified number of samples of ground water in California (detection limit and chlordane isomers not specified) [30]. Technical chlordane residues were found in ground water samples collected quarterly from 3 of 4 golf courses on Cape Cod between April 1986 and August 1987; the average concn at the positive golf courses ranged from 0.11 to 2.59 ppb and the overall range of concn was not detected (detection limit not specified) to 7.20 ppb [31]. The presence of chlordane in the golf course ground water samples was suggested to be due to either facilitated transport (i.e., macropore flow) or to cross contamination during well installation [31]. Chlordane (unspecified isomers) was found in one of 103 farmstead wells in Kansas sampled from December 1985 through February 1986 [119]. SURFACE WATER: Chlordane was detected in 340 of 603 samples collected in NJ between 1977-1979 with a max concn of 0.8 ppb [100]. cis- and trans-Chlordane have been positively detected in 56% of 820-827 USEPA STORET reporting stations; chlordane has been positively detected in 40% of 5250 reporting stations [117]. An average chlordane concn of 0.059 ppb was found in nearshore tributary waters of Lake Superior in 1973-1976 [74]. γ -Chlordane levels of 0.4-1.2 ppb were found in the lower Mississippi River during continuous monitoring in 1974 [19]. Mean concn of 0.1-0.4 ng/L were found in the Grand and Saugeen rivers (Ontario) in 1975-1977 [44]. Chlordane was found occasionally (<10% of samples positive) at up to 47 ng/L in water samples collected in 1975-1977 from streams in 11 agricultural watersheds in Ontario, Canada [45]. During 1975-1980 national surface water monitoring program, chlordane occurred in the surface water of 0.6% of the 177

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stations in the U.S. tested; a total of 2943 samples were taken [58]. RAINWATER: A mean chlordane (total of α - and γ -isomers) concn of less than 0.02 ng/L was detected in the rainwater collected at the remote Enewetak Atoll in the N Pacific Ocean in 1979 [8]. Chlordane was detected in 4 Hawaiian rainwater samples from 1971-2 at levels of 1-3 ppt [13]. γ -Chlordane was detected in unfiltered rainwater from urban and rural areas of Ontario, Canada, sampled between April and August 1981 at concn ranging from 0.1 to 0.9 ng/L [84]. Chlordane (total of cis- and trans-isomers) were detected in unfiltered rainwater from coastal suburban South Carolina sampled spring through fall in the years 1977 through 1979 at concn ranging from less than 0.2 to 5.9 ng/kg rain [84]. Chlordane was found in 35 of 36 samples of rainwater collected in Bermuda during 1983 and 1984 at maximum, median and avg concn of 0.486, 48 and 77 ng/L, respectively [73]. Chlordane (unspecified isomers) was found in 24 samples of rainwater collected in College Station, TX between Jan to May 1979 at concn ranging from 0.60 to 9.1 ng/L and an avg concn 2.14 ng/L [10].

Effluent Concentrations: Chlordane has been positively detected in 3.0% of 663 effluent reporting stations in the USEPA STORET data base system [117]. Preliminary results of the EPA Nationwide Urban Runoff Program have found 0.01-10 ppb chlordane in stormwater runoff from Lake Quinsigamond, MA and Kansas City, MO [32]. Chlordane has been qualitatively identified in various wastewater effluents from chemical factories [115]. Chlordane was found in 73% of 44 samples of sewage sludge from an unknown number of unspecified sites in the U.S. [48].

Sediment/Soil Concentrations: SOIL: Analysis of soil from 8 US cities (50 sites/city) in 1969 found positive chlordane concns of 300-1590 ng/g with positive detections/city ranging from 16-64% [132]. As part of the National Soils Monitoring Program, chlordane was detected in 117 of 1483 samples from 37 states in 1972 at an average concn of 0.05 ppm [26]; positive detection of 119 of 1461 soil samples from 37 states was made in 1971 with an average concn of 0.06 ppm [25]; positive detection of 165 of 1506 soil samples from 35 states was made in 1970 with a range of concn of 0.01 to 13.34 mg/kg [33]. Chlordane was found in 7.4% to 42.3% of 356 soil samples taken from 14 cities in the U.S. in 1970 at concn of 0.04-13.9 mg/kg [24]. Technical chlordane residues were found in soil core samples collected in December 1985 from three

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golf courses on Cape Cod at concn ranging from 4.75 to 4310 ppb [31]. The average concn in the top layers of soil (1 to 1.5 feet in depth) was 2278 ppb [31]. Chlordane was found in 52% of 25 samples of soil taken from the Everglades National Park in May 1976 at concn ranging from <1 ppb to 4.8 ppb and averaging 2.26 ppb [106]. It was found in 43% of 7 samples of soil taken from agricultural land in Florida in May 1976 at a maximum concn of 195 ppb and an average concn of 88 ppb [106]. SEDIMENTS: Chlordane was detected in the suspended sediment of the Upper Chesapeake Bay at 3 depths at average concn of 0.62-0.81 ppt [54]. Concn of 2-480 ppb were found in sediments of 32 ponds and rivers in RI in 1970-1 with 63% of all samples positive [97]. Concn of 0.3-1.8 ng/g detected in sediment from 14 sites in the Lake Erie Basin in 1973-1976 [74]. Chlordane isomers (γ and α) were found in core sediments (up to 250 cm deep) at concn of 34-127 ppb taken from the NY harbor [18]. Chlordane had positive detections in 46% of 1823 USEPA STORET reporting stations [117]. Mean concns of 0.2-6 ug/kg were found in suspended and bed sediment of the Grand and Saugeen rivers (Ontario) in 1976-77 [44]. Concn of less than 1.0 to 3 ug/kg were detected in sediment of the Apalachicola river (FL) in 1979 [38]. A sediment sample from Hawaii contained: 400-5270 ppt α -chlordane; 1330-5120 ppt γ -chlordane [131]. During 1975-1980 national surface water monitoring program, chlordane occurred in the sediment of 30% of the 171 stations tested; a total of 1014 samples were taken [58].

Atmospheric Concentrations: Chlordane concn of 0.006 to 0.015 ng/m³ were detected in the air at the remote Enewetak Atoll in the N Pacific Ocean in 1979 [8]; concn of 1.26 ng/m³ was detected at College Station TX [8]. Chlordane was found in 0.08% of samples collected in 1970-1971 in 30 states with a mean concn of 144.2 ng/m³ in the positive samples [77]. Concn of 0-0.012, 0.039-0.17 and 0.25 ng/m³ were detected in the ambient air of Bermuda, the Atlantic Ocean between Bermuda and RI, and Providence RI, respectively, in 1973 [14]. A mean concn of 0.0094 ng/m³ was detected in Barbados (1977-78) and 0.0042 ng/m³ was detected in Newfoundland in 1977 [16]. Concn of 0.001, 0.001, 0.002 ng/m³ were found in the Southern Pacific atmosphere near American Samoa, Peru, and New Zealand in 1979-81 monitoring [56]. Chlordane concn of 0.036 ng/m³ was detected in ambient air of the Texas Gulf coast in summer 1982 [28]. A mean concn of 0.4 ng/m³ was detected in ambient air monitoring of 10 US locations in 1980 with 11.4% positive

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detections out of 123 samples [27]. Chlordane concn of 0.0005-0.003 ng/m³ were detected in Arctic air between 1980-83 indicating its long range transport [95]. Chlordane was found in the indoor air of 7 out of 9 households in Jacksonville FL which used pesticides at concn ranging from 0.078 to 1.7 ug/m³ and averaging 0.64 ug/m³; the pesticide was found in the outdoor air in the vicinity of 3 of 9 of the house at concn ranging from 0.036 to 0.21 ug/m³ and averaging 0.082 ug/m³; personal air samples of one resident per household were found to be positive for chlordane at 6 of 9 houses at concn ranging from 0.063 to 4.2 ug/m³ and averaging 0.83 ug/m³ [79]. Chlordane (unspecified isomers) was found in 16 samples of air collected from two sites in College Station, TX between Feb 1979 to Feb 1980 at concn ranging from 0.32 to 2.64 ng/m³ and averaging 1.05 ng/m³ [10]. Chlordane was found in all 12 urban outdoor and all 12 indoor samples collected in Bloomington, IN between Nov 1985 and Oct 1986 at concn ranging from 0.8 to 49 ng/m³ and averaging 11 ng/m³ [3]. Chlordane was found in the following samples of air collected from Southeastern U.S. in Aug 1985: urban outdoor air - 67% of 9 samples positive, 210 ng/m³ max, 58 ng/m³ avg; indoor air, 89% of 9 samples positive, 1700 ng/m³ max, 510 ng/m³; and breathing zone air, 67% of 9 samples positive, 4200 ng/m³ max, 680 ng/m³ avg [78]. Chlordane was found in indoor air samples collected in New Jersey between 1976 and 1985 at levels up to 55,400 ng/m³ in living areas and up to 610,000 ng/m³ in non-living areas; 12-34% of the living areas and 44-48% of the non-living areas contained chlordane concn >5,000 ng/m³ [40]. Chlordane was found in 73% of 498 samples of indoor air collected 1980 from military base apartments at concn up to 37,800 ng/m³ and at an avg concn of 1,900 ng/m³ [80]. Between 1981 and 1982, chlordane was detected in 20.1% of 3,957 samples of indoor air from military housing at concn up to >5,000 ng/m³ [127].

Food Survey Values: In the US FDA's Total Diet Study (market basket survey of adult diet samples), chlordane was detected in 4 of 324 food composites (3 potato composites at concn ranging from trace to 0.002 ppm and 1 garden fruit composite at a trace concn) in sampling conducted from Oct 1980 to March 1982 [53]; it was found in 1 of 240 food composites (garden fruit at a concn of 0.003 ppm) in sampling conducted from Oct 1979 to Sept 1980 [52]; trace concentrations were found in 2 (potatoes, leafy vegetables) of 240 food composites while trans-chlordane was detected in one meat-fish-poultry composite at a

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concn of 0.001 ppm in sampling conducted from Oct 1977 to Sept 1978 [103]; Trace concentrations of chlordane were also found in 2 of 240 composites in each sampling conducted between Aug 1976 to Sept 1977 and Aug 1975 to July 1976 [69,70]. In the US FDA's Total Diet Study (market basket survey of infant and toddler diet samples), chlordane was detected in one of 143 toddler food composites (oils-fats at a concn of 0.005 ppm) in sampling conducted from Oct 1980 to March 1982 [50]; it was detected in one (oils-fats) of 110 toddler food composites at a concn of 0.0001 ppm in Oct 1979 to Sept 1980 sampling [51]; trace concn were found in one of 110 food composites for both infants and toddlers in Aug 1976 to Sept 1977 sampling [70]. In monitoring of pesticide residues in the total Canadian diet, chlordane was detected in garden fruits in 1976 to 1978 sampling [86]. Chlordane has been found in Canadian meat samples at levels ranging from 0-106 ug/kg in beef, 0-32 ug/kg in pork, and 0-70 ug/kg in fowl [111]. US Total Diet Survey for 1988 indicated that chlordane was found in 46 out of 1170 (4% occurrence) food items tested for pesticide residues (detection limit not reported) [42].

Plant Concentrations:

Fish/Seafood Concentrations: Chlordane concn of 300 ng/g was detected in channel catfish in the Ohio River in 1975 [89]. Concn of 72-200 ng/g were found in Iowa catfish in 1970-71 [92]. Chlordane was found in various estuarine fish in 4 of 21 coastal states surveyed between 1972 and 1976 with positive concns of 118-290 ng/g [21]. Concn of 0.8-14.0 ng/g found in the edible portion of fish taken near the shore of Lake Huron [59]. An average concn of 576 ppb was detected in various species from 22 watersheds near the Great Lakes in 1978 [130]. Concn of 8.54 ppb was found in composite fish samples from the Wabash and Ashtabula Rivers in OH [75]. Concn of 0-87 ng/g were detected in 20 fish species taken from Lake Erie in 1974-77 [74]. Concn of 2.39-6.43 ug/g and 0.39-0.83 ug/g were found in pike and herring, respectively, taken from the Baltic Sea in 1982 [91]. Concn from 0-610 ng/g were found in 48 samples (75% positive) of over 20 fish species taken from major watersheds near the Great Lakes in 1979 [76]. Mean concn of 0-5 ng/g were found in various fish species from Lake Texoma (TX-OK) in 1979 [64]. Mean concn of 0.07-0.12 ug/g were detected in finfish from MD waters between 1976-80 [37]. Twenty of 133 oysters collected from

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the South Atlantic and Gulf of Mexico contained chlordane; all but one had tissue residue concentrations greater than 0.01 mg/kg [20]. cis- and trans-Chlordane were found in 68% of 25 whole fish composite samples collected in 1986 from 13 sites located along a 125 mile stretch of the Kansas River [7].

Animal Concentrations: Chlordane levels of 0.02-0.04 ug/g were found in the brains, adipose tissue and muscle of 50 loons collected in 1979-80 in Ontario [46]. Concn up to 0.23 mg/kg were found in harp seals from the Northwest Atlantic and Arctic between 1976-78 [108]. Median cis-chlordane concn of 0.12-0.29 ppm were detected in carcasses of bald eagles from 32 states between 1978-81 with about 37% of the total 293 carcasses having positive detections [105]. cis-Chlordane levels up to 1.8 ppm were found in herons with positive detection found in 24 of 69 birds [96]. cis-Chlordane was present in 10 of 37 bald eagle carcasses collected in 1970-71 at concn of 0.11-7.4 mg/kg [34]. Chlordane (isomers unspecified) was analyzed for in the following categories of birds collected in Ontario between 1972 and 1988: seed-eating birds (41 birds, not detected (ND) to 0.05 mg/kg (wet tissue basis, limit of detection 0.001 mg/kg); birds feeding in an aquatic environment (65 birds, ND to 0.23 mg/kg, limit of detection 0.01 mg/kg); raptors (e.g., eagles, hawks, and owls) (24 birds, ND to 10.01 mg/kg, limit of detection 0.01 mg/kg); and gulls and terns (78 birds, ND to 0.93 mg/kg, limit of detection 0.005 mg/kg) [47]. Chlordane was found in 7.5% of 20 brood combs of honey bees collected in Connecticut between 1983 and 1985 at concn ranging in the positive samples from 0.06 to 0.69 ppm [4].

Milk Concentrations: Analysis of 3618 samples of bovine milk from 27,226 dairy farms of the Illinois Cooperative Extension found average chlordane levels of 0.01-0.06 ppm in 1972-76, 0.01 ppm in 1977-79 and 0.03 ppm in 1980-81 [118]. A median chlordane concn of 2 ppb was found in 1436 samples of USA human milk (74% positive detections) in 1975 [68]. 87% of 200 samples of cows' milk in Illinois 1971-1973 were found to be positive for chlordane; the concn found ranged from 0.02 to 0.06 mg/L and the average concentration was 50 ug/L [65,109]. All of the human milk samples in a study in Tokyo contained the chlordane residues oxychlordane & trans-nonachlor levels ranging from 0.1 to 1.1 ppb [90]. Oxychlordane was found in 46% of 57 human milk samples during 1973-74 in Arkansas and Mississippi; the maximum and mean

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concn were 20 and 5 ug/L, respectively [120]. The cis- and trans-chlordane concn in the milk of 4 healthy pregnant women averaged 154 and 125 ppb (whole milk weight), respectively; the range of total chlordane concn (cis- and trans-isomers) found in the four women over the course of the 20 week study ranged from not detected to 1.354 ppb [2]. Chlordane was not found in any of the human milk samples collected from 1436 women living in the U.S.; however, oxychlordane, a metabolite of chlordane, was found in 74% of the samples tested maximum and mean concn of >500 and 95.8 ppb, respectively [112]. The following concn of chlordane residues were found on 210 samples of human breast milk collected in 1982 from women in 5 different regions across Canada; whole milk: α -chlordane (1 ng/g avg of positive samples, 4 ng/g max), γ -chlordane (1 ng/g avg, 2 ng/g max), trans-nonachlor (1 ng/g avg, 3 ng/g max); milk fat: α -chlordane (27 ng/g avg, 84 ng/g max), γ -chlordane (10 ng/g avg, 84 ng/g max), trans-nonachlor (27 ng/g avg, 166 ng/g max) [88]. trans-Nonachlor, α - and γ -chlordane were found in 99%, 56%, and 73% of the samples, respectively [88].

Other Environmental Concentrations: cis-Chlordane was detected in 8 black-crowned night-heron eggs collected in 1979 in WY and CO at a range of 0.08-0.23 ppm [85]. cis-Chlordane was found in 6 of 28 Great Black-Backed Gull eggs from Maine in 1977 at a range of 0-0.50 ppm [123]. cis- and trans-Chlordane were found in 78-81% of sampled Canadian chicken eggs at average levels of 1-2 ug/kg [87].

Probable Routes of Human Exposure: Major general population exposure to chlordane can occur through oral consumption of contaminated food and inhalation of contaminated air. Occupational exposure by dermal and inhalation routes related to the use of chlordane as an insecticide may be significant.

Average Daily Intake: FOOD INTAKE: Based on monitoring from the US FDA's Total Diet Study (market basket survey of adult diet samples), the average daily intake of total chlordane (chlordane plus octachlor epoxide) has been reported to be 0.004, 0.004, 0.004, 0.003, and 0.004 ug/kg body wt for fiscal years 1977, 1978, 1979, 1980, and 1981-82 respectively [52,53]. Based on monitoring of Canadian total diet samples between 1976 and 1978, the AVDI for chlordane has been reported to be less than 0.001 ug/kg body wt [86]. Based on monitoring from the US

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FDA's Total Diet Study (toddler diet samples), the average daily intake of total chlordane (chlordane plus octachlor epoxide) has been reported to be 0.005, 0.032, 0.003, 0.005, and 0.003 ug/kg body wt for fiscal years 1977, 1978, 1979, 1980, and 1981-82 respectively [49,50,52,53]. Based on monitoring from the US FDA's Total Diet Study (infant diet samples), the average daily intake of total chlordane (chlordane plus octachlor epoxide) has been reported to be 0.001, 0.010, <0.001, 0.003, and 0.002 ug/kg body wt for fiscal years 1977, 1978, 1979, 1980, and 1981-82 respectively [52]. AIR INTAKE: Assuming the average air concn of chlordane ranges from 0.001 to 0.4 ng/m³, the AVDI may range from 0.02-8.0 ng. WATER INTAKE: Insufficient data.

Occupational Exposure:

Body Burdens: A median chlordane concn of 2 ppb was found in 1436 samples of USA human milk (74% positive detections) in 1975 [68]. Chlordane has apparently persisted on the hands of a former pest control operator for at least 2 yr after the last known exposure [71]. All of the human milk samples in a study in Tokyo contained the chlordane residues oxychlordane & trans-nonachlor levels ranging from 0.1 to 1.1 ppb [90]. Chlordane was not found in any of the human milk samples collected from 1436 women living in the U.S.; however, oxychlordane, a metabolite of chlordane, was found in 74% of the samples tested maximum and mean concn of >500 and 95.8 ppb, respectively [112]. Oxychlordane was found in 46% of 57 human milk samples during 1973-74 in Arkansas and Mississippi; the maximum and mean concn were 20 and 5 ug/L, respectively [120]. Total chlordane concn (total of cis- and trans-isomers) in the placental tissues of 4 healthy pregnant women ranged from 5 to 137 ppb (total tissue weight basis) and averaged 42 ppb; cis- and trans-chlordane concn in the milk of these women averaged 154 and 125 ppb (whole milk weight), respectively [2]. The range of total chlordane concn found in the four women over the course of the 20 week study ranged from not detected to 1.354 ppb [2]. None of the levels of chlordane-related compounds in the blood plasma of workers chronically exposed to chlordane decreased over a period of eight months after the last known exposure to chlordane [125]. Technical chlordane constituents cis- and trans-nonachlor and chlordane metabolite oxychlordane were detected in all of the samples of human adipose tissue obtained in 1984 during autopsies of 141 persons from 6 Canadian Great Lakes cities;

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constituents α - and γ -chlordane, and heptachlor as well as chlordane metabolite chlordene were not detected in any of the samples [133]. The following concn of chlordane residues were found on 210 samples of human breast milk collected in 1982 from women in 5 different regions across Canada; whole milk: α -chlordane (1 ng/g avg of positive samples, 4 ng/g max), γ -chlordane (1 ng/g avg, 2 ng/g max), trans-nonachlor (1 ng/g avg, 3 ng/g max); milk fat: α -chlordane (27 ng/g avg, 84 ng/g max), γ -chlordane (10 ng/g avg, 84 ng/g max), trans-nonachlor (27 ng/g avg, 166 ng/g max) [88]. Trans-nonachlor, α - and γ -chlordane were found in 99%, 56%, and 73% of the samples, respectively [88]. Chlordane residues were found in 95% of 785 samples of human adipose tissue collected in the U.S. between 1976 and 1980 at concn up to >10 ppb; 4% of 4200 samples of human blood sera contained chlordane residues at up to >1 ppb [93].

REFERENCES

1. Abrams EF et al; Identification of Org Compounds in Effluents from Industrial Sources USEPA-560/3-75-002 (1975)
2. Al-Omar M et al; Environ Pollut Ser A Ecol Biof 42 (1): 79-92 (1986)
3. Anderson DJ, Hites RA; Environ Sci Technol 22: 717-20 (1988)
4. Anderson JF, Wojtes MA; J Econ Entomol 79: 1200-5 (1986)
5. Ang C et al; Bull Environ Contam Toxicol 42: 595-602 (1989)
6. Anonymous; Morbidity, Mortality Weekly Rep 30: 571-2 (1981)
7. Arruda JA et al; Bull Environ Contam Toxicol 39: 563-70 (1987)
8. Atlas E, Giam CS; Sci 211: 163-5 (1981)
9. Atlas E et al; Environ Sci Technol 16: 283-6 (1982)
10. Atlas E, Giam CS; Water Air Soil Pollut 38: 19-36 (1987)
11. ATSDR; Toxicological Profile for Chlordane. Draft for Public Comment. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service p 77 (1989)
12. Beeman RW, Matsumura F; J Agric Food Chem 29: 84-9 (1981)
13. Bevenue A et al; Bull Environ Contam Toxicol 8: 238 (1972)
14. Bidleman TF, Olney CE; Sci 183: 516 (1974)
15. Bidleman TF, Christensen EJ; J Geophys Res 84: 7857 (1979)
16. Bidleman TF et al; J Marine Res 39: 443 (1981)
17. Bidleman TF et al; Environ Sci Technol 20: 1038-43 (1986)
18. Bopp RF et al; Environ Sci Technol 16: 666 (1982)
19. Brodtmann NV Jr; Bull Environ Contam Toxicol 1: 33 (1976)
20. Bugg JC; Pestic Monit J 1: 9-12 (1967)
21. Butler PA, Schutzmann RL; Pestic Monit J 12: 51 (1978)
22. Callahan MA et al; Water-Related Environ Fate of 129 Priority Pollut USEPA-440/4-79-029A (1979)

CHLORDANE

Chlordane

23. Cardwell RS; Acute and Chronic Toxicity of Chlordane to Fish and Invertebrates EPA 600/3-77-019 (1977)
24. Carey AE et al; Pestic Monit J 10: 54-60 (1976)
25. Carey AE et al; Pestic Monit J 12: 117 (1978)
26. Carey AE et al; Pestic Monit J 12: 209 (1979)
27. Carey AE, Kutz FW; Environ Monit Assess 5: 155 (1985)
28. Chang LW et al; Int J Environ Anal Chem 19: 145 (1985)
29. CLOGP; PCGEMS Graphical Exposure Modeling System USEPA (1986)
30. Cohen DB; Am Chem Soc Symp Ser 315: 499-529 (1986)
31. Cohen SZ et al; Ground Water Monit Rev 10: 160-73 (1990)
32. Cole RH et al; J Water Pollut Contr Fed 56: 898 (1984)
33. Crockett AB et al; Pestic Monit J 8: 69-97 (1974)
34. Cromartie E et al; Pestic Monit J 9: 11 (1975)
35. Dorrough HF et al; J Agric Food Chem 20: 42 (1972)
36. Eichelberger JW, Lichtenberg JJ; Environ Sci Technol 5: 541-4 (1971)
37. Eisenberg M, Topping JJ; J Environ Sci Health B20: 729 (1985)
38. Elder JF, Matraw HC Jr; Arch Environ Contam Toxicol 13: 453 (1984)
39. EXAMS; Exposure analysis modeling system. EXAMS II. USEPA, Environ Res Lab, Athens, GA. EPA/600/3-85/038 (1985)
40. Fenske RA, Sternbach T; Bull Environ Contam Toxicol 39: 903-10 (1987)
41. Feroz M et al; J Agric Food Chem 29: 272 (1981)
42. Food and Drug Administration; J Assoc Off Analyt Chem 72: 5-24 (1989)
43. Foreman WT, Bidleman TF; Environ Sci Technol 21: 869-75 (1987)
44. Frank R; J Great Lakes Res 7: 440 (1981)
45. Frank R et al; J Environ Qual 11: 497-505 (1982)
46. Frank R et al; Arch Environ Contam Toxicol 12: 641 (1983)
47. Frank R, Braun HE; Bull Environ Contam Toxicol 44: 932-9 (1990)
48. Fricke C et al; BioCycle 26: 35-7 (1985)
49. Gartrell MJ et al; J Assoc Off Anal Chem 68: 842-61 (1985)
50. Gartrell MJ et al; J Assoc Off Anal Chem 68: 123-44 (1985)
51. Gartrell MJ et al; J Assoc Off Anal Chem 68: 1163-83 (1985)
52. Gartrell MJ et al; J Assoc Off Anal Chem 68: 1184-97 (1985)
53. Gartrell MJ et al; J Assoc Off Anal Chem 69: 146-61 (1986)
54. Gay BW, Noonan RC; Ambient Air Measurements of Vinyl Chloride in the Niagara Falls Area; Environ Monitoring Series USEPA-650/4-75-020 (1975)
55. GEMS; Graphical Exposure Modeling System FAP Fate of Atmos Pollut (1986)
56. Giam CS, Atlas E; Amer Chem Soc 25: 5 (1985)
57. Gianessi LP; A National Pesticide Usage Data Base. Summary of report submitted to the Office of Standards and Regulations. USEPA under cooperative agreement CR 811858-01-0 by Resources for the Future, Wash, DC. Feb (1986)
58. Gilliom RJ; Pestic in Rivers of the U.S. Nat Water Summary 1984 - Water Qual Issues, Hydrologic Perspectives, 85-92 (1984)
59. Glass GE et al; Organic Contaminants - Lake Huron USEPA-600/J-77-063 (1977)
60. Glooschenko V et al; Bull Environ Contam Toxicol 21: 515 (1979)
61. Glofelty DE et al; J Agric Food Chem 32: 638 (1984)
62. Gore RC et al; J Assoc Off Anal Chem 54: 1040-82 (1971)

Chlordane

63. Harrington JM et al; Environ Res 15: 155-9 (1978)
64. Hunter RG et al; Pestic Monit J 14: 102 (1980)
65. IARC: Some Halogenated Hydrocarbons 20: 45 (1979)
66. Ivie GW et al; Bull Environ Contam Toxicol 7: 376 (1972)
67. Iyengar L, Rao AVSP; J Gen Appl Microbiol 19: 321 (1973)
68. Jensen AA; Res Rev 89: 1 (1983)
69. Johnson RD et al; Pestic Monit J 15: 54 (1981)
70. Johnson RD et al; J Assoc Off Anal Chem 67: 154 (1984)
71. Kazen C et al; Arch Environ Health 29: 315-8 (1974)
72. Kenaga EE; Environ Sci Technol 14: 553 (1980)
73. Knap AH et al; Atmos Environ 22: 1411-23 (1988)
74. Konasewich D et al; Status Report on Org and Heavy Metal Contaminants in the Lakes Erie, Michigan, Huron and Superior Basins (1978)
75. Kuehl DW et al; J Assoc Off Anal Chem 63: 1238 (1980)
76. Kuehl DW et al; Environ Int 9: 293-9 (1983)
77. Lee RE Jr; p 37 in Proc Inter Clean Air Congress, 4th ed. Res Triangle Park, NC: USEPA Health Effects Lab (1977)
78. Lewis RG et al; Proc Air Pollut Control Assoc 79th Ann Mtg 86: 37.4 (1986)
79. Lewis RG et al; Environ Monit Assessment 10: 50-73 (1988)
80. Livingston JM, Jones CR; Bull Environ Contam Toxicol 27: 406-11 (1981)
81. CLOGP; PCGEMS Graphical Exposure Modeling System USEPA (1986)
82. Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds. McGraw-Hill NY (1982)
83. Mabey WR et al; Aquatic Fate Process Data for Organic Priority Pollut USEPA-440/4-81-014 (1981)
84. Mazurek MA, Simoneit BRT; Crit Rev Environ Control 16: 1-140 (1986)
85. McEwen LC et al; Environ Toxicol Chem 3: 367 (1984)
86. McLeod HA et al; J Food Safety 2: 141 (1980)
87. Mes J et al; Pestic Monit J 8: 8 (1974)
88. Mes J et al; Food Additives Contaminants 3: 313-22 (1986)
89. Miles RL; Commercial Fishery Investigations; Completion Report, National Marine Fisheries Service, Washington DC (1977)
90. Miyazaki T et al; Bull Environ Contam Toxicol 25: 518-23 (1980)
91. Moilanen R et al; Bull Environ Contam Toxicol 29: 334 (1982)
92. Morris RL et al; Health Lab Sci 9: 145 (1972)
93. Murphy RS et al; Environ Health Perspec 48: 81-6 (1983)
94. National Res Council Canada; Chlordane; Its Effects on Canadian Ecosystems and its Chemistry NRCC No.14094 (1974)
95. Oehme M, Ottar B; Geophys Res Lett 11: 1133 (1984)
96. Ohlendorf HM et al; Pestic Monit J 14: 125 (1981)
97. Olney CE; Gov Rep Announce 73: 147 (1973)
98. Oloffs et al; Can J Microbiol 18: 1393-8 (1972)
99. Oloffs et al; J Fish Res Board Can 30: 1619-23 (1973)
100. Page GW; Environ Sci Technol 15: 1475 (1981)
101. Parrish PR et al; p 67 in Chronic Toxicity of Chlordane, Trifluralin, and Pentachlorophenol to Sheepshead Minnows NTIS PB-278 269 (1978)
102. Podowski
103. Podrebar
104. Rao PSC
Phospho
105. Reichel
106. Requejo
107. Roberts
108. Ronald F
109. Safe Drin
Nat Acac
110. Sanborn
Literature
111. Saschenb
112. Savage E
113. Schafer N
114. Schimme
115. Shackelfe
USEPA-
116. Speidel F
117. Staples C
118. Steffey K
119. Steichen
120. Strassmar
121. Suntio LF
122. Swann R
123. Szaro RC
124. Tabak H
125. Takamiya
126. Tucker W
127. USEPA;
Subterrane
USEPA,
128. USEPA;
129. Veith GD
130. Veith GD
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ed Van N
132. Wiersma
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135. Wilson D
136. Worthing
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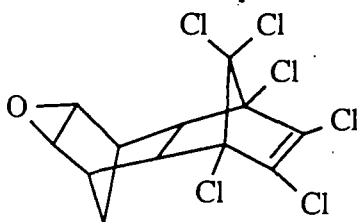
102. Podowski AA et al; Arch Environ Contam Toxicol 8: 509 (1979)
103. Podrebarac DS; J Assoc Off Anal Chem 67: 176 (1984)
104. Rao PSC, Davidson JM; Retention and Transformation of Selected Pestic and Phosphorus in Soil-Water Systems: A Critical Rev USEPA-600/53-82-060 (1982)
105. Reichel WL et al; Environ Monit Assess 4: 395 (1984)
106. Requejo AG et al; Environ Sci Technol 13: 931-5 (1979)
107. Roberts JR et al; J Fish Res Board Can 34: 89 (1977)
108. Ronald K et al; Sci Total Environ 38: 133 (1984)
109. Safe Drinking Water Committee; Drinking Water and Health. Nat Res Council, Nat Acad Sci, Washington, DC pp 559-60 (1977)
110. Sanborn JR et al; The Degradation of Selected Pestic in Soil: A Rev of Published Literature USEPA-600/9-77-022 p 616 (1977)
111. Saschenbrecker PW; Can Vet J 17: 158 (1976)
112. Savage EP et al; Am J Epidemiol 113: 413-22 (1981)
113. Schafer ML et al; Environ Sci Technol 3: 1261-9 (1969)
114. Schimmel SC et al; J Toxicol Environ Health 2: 169 (1976)
115. Shackelford WM, Keith LH; Frequency of Org Compounds Identified in Water USEPA-600/4-76-062 (1976)
116. Speidel HK et al; Dev Ind Microbiol 13: 277 (1972)
117. Staples CA et al; Environ Toxicol Chem 4: 131 (1985)
118. Steffey KL et al; J Environ Sci Health B19: 49 (1984)
119. Steichen J et al; Ground Water Monit Rev 8: 153-60 (1988)
120. Strassman SC, Kurtz FW; Pestic Monit J 10: 130 (1977)
121. Suntio LR et al; Rev Environ Contam Toxicol 103: 1-59 (1988)
122. Swann RL et al; Res Rev 85: 17 (1983)
123. Szaro RC et al; Bull Environ Contam Toxicol 22: 394 (1979)
124. Tabak HH et al; J Water Pollut Contr Fed 53: 1503 (1981)
125. Takamiya K; Bull Environ Contam Toxicol 44: 905-9 (1990)
126. Tucker WA, Preston AL; Water, Air, Soil Pollut 21: 247 (1984)
127. USEPA; Analysis of the Risks and Benefits of Seven Chemicals Used for Subterranean Termite Control. Office of Pesticides and Toxic Substances, USEPA, Washington, DC (1983)
128. USEPA; Fed Register 53: 11798-805 (1988)
129. Veith GD et al; J Fish Res Board Can 36: 1040 (1979)
130. Veith GD et al; Pestic Monit J 15: 1 (1981)
131. Verschuere K; Handbook of Environmental Data on Organic Compounds 2nd ed Van Nostrand Reinhold NY p 352 (1983)
132. Wiersma GB et al; Pestic Monit J 6: 126 (1972)
133. Williams DT et al; J Assoc Off Anal Chem 71: 410-4 (1988)
134. Williams WM et al; Pesticides in Ground Water Data Base: 1988 Interim Report. (NTIS PB89164230AS) pp 3-8 (1988)
135. Wilson DM, Oloffs PC; Can J Soil Sci 53: 465 (1973)
136. Worthing CR; The Pesticide Manual 8th ed Croydon, England: The British Crop Protection Council pp 145-6 (1987)

Dieldrin

SUBSTANCE IDENTIFICATION

Synonyms: (1 α ,2 β ,2 α ,3 β ,6 β ,6 α ,7 β ,7 α)-3,4,5,6,9,9-Hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-2,7:3,6-dimethanonaphth(2,3-b)oxirene

Structure:



CAS Registry Number: 60-57-1

Molecular Formula: C₁₂H₈Cl₆O

Wiswesser Line Notation: T E3 D5 C555 A D- FO KUTJ AG AG BG JG KG LG ENDO EXO

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point:

Melting Point: 175-176 °C

Molecular Weight: 380.93

Dissociation Constants:

Log Octanol/Water Partition Coefficient: 4.32 [38]

Water Solubility: 0.17 mg/L at 20 °C [86]

Vapor Pressure: 3.75 x 10⁻⁶ mm Hg at 20 °C [86]

Henry's Law Constant: 5.8 x 10⁻⁵ atm m³/mole at 25 °C [95]

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ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Summary: Dieldrin has been used extensively in the past as an insecticide for corn and for termite control, although it is no longer registered for general use. Dieldrin is extremely persistent, but it is known to slowly photorearrange to photodieldrin (water half-life - 4 months). Dieldrin release to soil will persist for long periods (> 7 yr), will reach the air either through slow evaporation or adsorption on dust particles and subsequent suspension in air. It will not leach into ground water, and will reach surface water mostly through agricultural runoff. Once dieldrin reaches surface waters, it will adsorb strongly to sediments, bioconcentrate in fish and slowly photodegrade. Biodegradation and hydrolysis are unimportant processes. Fate of dieldrin in the atmosphere is unknown but monitoring data has demonstrated that it can be carried long distances. Measured data demonstrate that dieldrin continues to be a contaminant in air, water, sediment, soil, fish, and other aquatic organisms, wildlife, foods, and humans. Human exposure appears to come mostly from food.

Natural Sources: Dieldrin is not known to occur naturally.

Artificial Sources: Dieldrin has been used as an insecticide mostly for corn and in smaller amounts for termite control [42]. It is also an environmental degradation product of the insecticide, aldrin [93]. Aldrin and dieldrin are no longer registered as general use insecticides [93].

Terrestrial Fate: Dieldrin released to soils will persist for extremely long periods of time (>7 yr). Its low water solubility and strong adsorption to soil makes leaching into ground water unlikely. Small amounts may volatilize from soil or be carried on dust particles into the air. Soil runoff will carry particle-associated dieldrin to water systems [77].

Aquatic Fate: Dieldrin released to water systems will not undergo hydrolysis or appreciable biodegradation. It will photorearrange to photodieldrin with a half-life of approximately 4 months. Photorearrangement will be somewhat faster in waters containing photosensitizers. Adsorption to sediments and bioconcentration in aquatic organisms are likely to be important aquatic processes. Evaporation from

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Dieldrin

water may be an important process, but conflicting data are available (half-life of hr to months). In a modeling study of a reservoir, it was concluded that 40% of the inflow was lost to the bottom via sedimentation, 50% released through the outflow because of the short detention time, and 10% will go to fish because of the high biomass concentration in the reservoir [77]. At low flow conditions, the sediment will become a net source of dieldrin in water via desorption and pore water diffusion through sediment [77].

Atmospheric Fate: Little is known about the fate of dieldrin in the atmosphere. Because of its low vapor pressure and high *K_{oc}*, dieldrin is probably associated with particulate matter in air. Vapor phase photodegradation has been reported but its rate is not known. The observed long distance transport of dieldrin in air is indicative that it has a long residence time.

Biodegradation: Dieldrin is not biodegraded in standard screening tests [88] and is extremely persistent in soils [73] under both aerobic and anaerobic conditions [16]. It took 7 yr for half of the dieldrin to disappear from soil field plots [62]. No biodegradation in river waters has been noted [78,23]. There is some evidence that microorganisms can form photodieldrin from dieldrin [56,62]. A mixed anaerobic population degraded dieldrin with the formation of two dechlorinated products [58]. However, no or little biodegradation was observed with activated sludge under anaerobic digestion [5,49].

Abiotic Degradation: Hydrolysis is not an important degradation process for dieldrin in water [13,23]; half-life is greater than 4 years [13]. Estimated hydrolysis half-life at pH 7 is 10.5 years [26]. When irradiated with sunlight, dieldrin degrades to photodieldrin [13]; in distilled water, the half-life is approximately 2 months [13]. Dieldrin photodegradation to photodieldrin is aided by rotenone and to a lesser extent by natural triplet sensitizers, such as chlorophyll [44]. Vapor phase photodegradation of dieldrin to photodieldrin has also been noted [18], but no data are available to estimate the rate of atmospheric photodegradation [13]. The observed degradation was only 1% when dieldrin adsorbed on silica gel was irradiated for 17 hr. with light of wavelengths greater than 290 nm [33]. Therefore, photodegradation of particle-sorbed dieldrin may not be important.

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Bioconcentration: Moderate to significant bioconcentration (100 to 10,000) in various aquatic species [13]. BCF of 3-6000 in fish [60,73]. Estimated log BCF reported as 4.10 [43]. The biotransfer factor defined as the ratio of concn in food (mg/kg) over daily intake of dieldrin (mg/day) from beef, milk and vegetable are 0.008, 0.011 and 0.098, respectively [91].

Soil Adsorption/Mobility: Measured log Koc value range 3.87-4.08 [11,46]. Rf value for soil thin layer chromatography- 0.00 [11,39]. Even with high temperatures and prolonged leaching, dieldrin will be immobile in most soils [25].

Volatilization from Water/Soil: Conflicting data exist on the rate of evaporation of dieldrin from water [4]. Its experimental volatilization rate is 5% of the oxygen reaeration rate [4]. Using oxygen reaeration rates for ponds, rivers, or lakes [80], the half-life for evaporation would be 72, 14, and 57 days, respectively. However, in another study using distilled and natural waters with gentle agitation, the half-lives for evaporation were 6 to 9 hr [13]. Using a Henry's Law constant of 5.8×10^{-5} atm m³/mole [95], the evaporation half-life from a model river of depth 1 m, flowing at a current velocity of 1 m/sec and a wind velocity of 3 m/sec is estimated [55] to be 1.4 days. When adsorption to suspended matter and sediment is considered, the evaporation half-life will be higher than the estimated value of 1.4 days. Dieldrin's low vapor pressure (3.75×10^{-6} mm Hg at 20 °C) [86], suggests only limited evaporation from soil which agrees with terrestrial microcosm studies [35] and various field studies [72]. Volatilization increased as moisture content of the soil increased [72]. Land disposal of dieldrin to a silt loam soil at initial application rates of 7.5 ug/cm³ at a depth of 0.5 cm and 14 ug/cm³ at a depth of 11 cm resulted in volatilization rates of 105 and 340 ng/cm²-day, respectively after two days of disposal [90].

Water Concentrations: DRINKING WATER: Hawaii 0.3 ppt avg, 1970-71; Virgin Islands 0.19 ppb in 50% of cistern waters [42]; New Orleans - 3 plants 0.05-0.07 ppb [48]. Rural counties, SC 37% pos, 0-153 ppt, 55 ppt mean [74]. GROUND WATER: Nebraska, 1978 below detection limit (5 ppt) [81]. NJ 1977-1979- 604 samples, trace (0.1 ppb)-90th percentile, highest value 0.9 ppb [64]. SURFACE WATER: US rivers and lakes 0-0.1 ppb 1960's-1972 [42]. Dutch rivers 1967-1977

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0.02-0.06 ppb max values, not detectable in last 2 yr [96]. NJ 1977-79 (604 samples), trace (0.1 ppb)-90th percentile [64]. Ontario 11 agricultural watersheds 1.6-1.7 ppt overall mean 1975-77 [32]. South Florida 1968-72- 367 samples 11% pos [57]. Lake Ontario water collected in 1983- 0.26-0.63 ng/L [8]. RAINWATER: Great Lakes collected in 1976-1977-range of mean concn 0.5-2.6 ppt [50]. Avg. rainwater concn range 5-42 ppt [42]. Lake Superior in 1983- 0.56 ng/L [84].

Effluent Concentrations: Municipal effluent 0.004-0.052 ppb [50]. Foundries water effluent 6 samples, 6 pos 5 ppb avg; textile mills 50 samples, 1 pos 0.2 ppb [94]. Detected in 3.7% of 676 U.S. effluent samples at a median concn less than 0.01 ppb [83].

Sediment/Soil Concentrations: SEDIMENT: Illinois lakes 0-34 ppb [70]; South Florida 1968-72- 287 samples 55% pos, 0.1-900 ppb, median 1 ppb [57]; Lake Erie 255 samples 1.6 ppb mean, Lake Huron 0-4.5 ppb, Lake Michigan <5 ppb [50]. Upper Rockaway River, NJ- 0.1-5.2 ppb and level increased with increase in organic carbon content of sediment [79]. SOILS: US Agric - 1972, 1481 samples, 27% pos, 0.04 ppm mean [15]. Urban, 1971, 5 cities, 380 total samples 7-29% pos, < 0.01-0.06 ppm, mean [14].

Atmospheric Concentrations: Airborne dust in London, England- 0-8.1 ppb [42]. Orlando, FL- 1.9 ppt [82]. USA 1970-71 98% pos 0.1 ppt mean [52]. Great Lakes 0.0006-0.006 ppt, 0.003 ppt mean [24]. Barbados 1977-78 19 samples, 13 pos 0.00033 ppt, total mean; Newfoundland, 1977- 6 samples, 6 pos, 0.00055 ppt mean [9]; Boston, MA and Columbia, SC, June-Aug 1978, 0.002 ppt and 0.025 ppt, respectively [10]. Enewetak Atoll, N Pacific - 17 samples, 0.00063 ppt mean [3]. College Station, TX in 1979- air, 0.08 ng/m³ avg; rainfall, 0.80 ng/L avg [2]. Level in Canadian arctic snow in 1986- 0.17-1.63 ng/L [36]. This is evidence of long range atmospheric transport of dieldrin [36]. Detected in 5 indoor and 3 outdoor air of 9 homes in southeastern U.S. known to have been treated with pesticides for termite control [53].

Food Survey Values: Cheese - domestic 784 samples, 34.2% pos, 0.031 ppm avg; imported 5471 samples, 22.7% pos, 0.015 ppm, avg [22]. Red meat 15200 samples, 50.7% pos, 0.047 ppm avg [22]. Poultry 11340

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samples, 72.5% pos, 0.054 ppm, avg [22]. Eggs - domestic 2303 samples, 15.5% pos, 0.012 ppm, avg [22]. Large fruits - domestic 3281 samples, 7.4% pos, 0.002 ppm avg; imported 1048 samples, 7.9% pos, 0.002 ppm, avg; small fruits - domestic 1445 samples, 6.4% pos, 0.002 ppm, avg, imported - 2119 samples, 2.1% pos, 0.0007 ppm, avg [22]. Leaf and stem vegetables domestic 5319 samples, 2.5% pos, 0.0006 ppm, avg; imported 312 samples, 1.8% pos, 0.0003 avg [22]. Vine and ear vegetables domestic 2954 samples, 10.5% pos, 0.003 ppm, avg; imported 4117 samples, 17.6 pos, 0.004 ppm avg [22]. Also frequently detected in beans, root vegetables, whole grains, corn and corn products, cotton seeds and cotton seed products, peanuts and peanut products, soybeans and soybean products, miscellaneous animal feed and hay and dehydrated hay [22]. 1971-76 average dietary intake 0.00004 mg/kg body weight/day [22]. Positive composites - % daily intake (ug): 1971-30.8% (3.0), 1972-26.2 (2.0), 1973-29.7 (3.0), 1974-25.8 (4.0), 1975-23.8 (3.0), 1976-24.6 (3.0) [22]. Of 19,851 domestic and imported food and feed commodities analyzed during 1981-1986, dieldrin was detected in 457 samples at non-detected-0.05 ppm and in 12 samples at greater than 0.05-0.10 ppm [54]. Canadian food composites in 1985- leafy vegetables, 0.0031 ppm; fruit, 0.00011 ppm; root veg., 0.023 ppm; milk, 0.0019; eggs/meat, 0.0031 ppm [20]. U.S. domestic and imported agricultural food and feed sampled in 1981-1986- of a total of 6301 domestic samples, detected at non-detected- 0.05 ppm in 42 samples and greater than 0.05-0.10 ppm in 2 samples; of a total of 12,044 imported samples, detected at none detected-0.05 ppm in 411 samples and greater than 0.05-0.10 ppm in 9 samples [40]. Detected at a frequency of 10% in total U.S. diet study in 1988 [29].

Plant Concentrations: USA 1972 variety crops means of <0.01-0.21 ppm [14].

Fish/Seafood Concentrations: Fish from Illinois lakes ND-410 ppb [70]; Lake Superior trout 0.028 ppm mean, all stations (24 fish) [87]; Wisconsin river fish 0.008-0.022 ppm [66]; Great Lakes fish 0.01-0.25 ppm [50] fish fat 0.002-6.7 ppm, whole fish 0-1.59 ppm [42]; Great Lakes white fish 13-215 ppb [47]; Fish in Lake Texonia, TX and OK 0-144 ppb [41]; USA 1972-76 Nat Pest Monit Program, estuarine fish 1972-7% pos, 140 ppb max, 1976 0% pos [12]; US 1970-74 Nat. Pest. Monit. Prog freshwater fish 1970-100% pos 1.1 ppb lipid mean,

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1974-53% pos 0.6 ppb lipid, mean [76]. Pacific oysters 1972-73 ND-0.39 [85]; marine fish and seafood 0.1-140 ppb [68]; marine fish and seafood 1-12000 ppb [67]; fish 1970-76 domestic 2901 samples, 46.3% pos, 0.045 ppm, avg; imported - 361 samples, 23.5 pos, 0.013 ppm, avg [22]; shellfish 1970-76 domestic 291 samples, 27.5% pos, 0.005 ppm, avg; imported 152 samples, 12.4% pos, 0.002 ppm avg [22]. Bluefish (whole) from MA collected in 1986- uncooked, 0.01-0.04; cooked, 0.01-0.05 [92]. Mean concn (ppm) in fillets of 3-yr-old fall run coho salmon collected from different lakes in 1984- Superior, 0.01; Huron, 0.02; Michigan, 0.01; Erie, 0.01; Ontario, 0.02 [21]. There is a decreasing trend in concn in fish fillet from 1980 to 1984 [21].

Animal Concentrations: Seabirds - Bay of Fundy, Canada 0.01-3.56 ppm [34]; Missouri, gray bats, 1976-78 600-900 ppm lipid [17]; Great Lakes birds ND-0.36 ppm [50]. Birds 0.01-0.4 ppm, fatty tissue, 0.6-4.3 ppm liver; eagles - trace - 6 ppm, birds eggs 0.01-1.5 ppm [42]. USA Ospreys, 1964-73, ND-3.8 ppm [98]. Seals - Gulf of St. Lawrence 1971 <0.002-0.32 ppm [71]; herons, 1966-73 Great Lakes 103 samples, 62 pos, 0.14-14 ppm [63]; loons, Ontario, Canada 1968-80 0.13-1.57 ppm [31]. USA Nationwide starlings- per cent positive samples for dieldrin and aldrin combined between 1972 and 1978 ranged from 92.3-100% with avg residues of 0.04-0.09 ppm. This dropped radically to 61.4% pos and 0.07 ppm avg in 1979 to 4.5% and 5.9% pos in 1980 and 1981 with <0.001 ppm avg residues [97]. Concentration in blubber tissue of seals collected from coast of England - 0.16-0.23 ppm weight wt [51]. Similarly, dieldrin has been detected in arctic cod muscle and in the bubbler and liver of arctic seals [61].

Milk Concentrations: In U.S. and Canada avg concn in milk fat- 0.03 to 0.04 ppm [42]. Cow's milk from Binghamton, NY collected in 1986-1987- ultrapasteurized, 0.006 ppm (lipid basis); Crowley milk, 0.003 ppm [lipid basis] [75].

Other Environmental Concentrations: Herring gulls collected in 1981- egg, 2.11 mg/kg fat avg; 5-day-old chick, 3.98 mg/kg fat avg [6]. Whole falcon eggs collected in Arizona, 1978-1982- none detected- 0.2 ppm [28]. Level of dieldrin in seabird eggs were lower in the mid 1980s than those in 1970s [27]. Others have detected dieldrin in eggs of seabirds in the northwest Atlantic [65]. Residue level (ppm weight wt) in fat of

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wintering ducks in Niagara River, NY during 1984-1985- 0.10-0.69 [30]. House dust from Seattle, WA- 1.1 ppm and contaminated soil has been speculated to be the source [69].

Probable Routes of Human Exposure: Dieldrin is a very persistent insecticide and even though it is not used extensively now, residues are still detected in water, soils, sediments, fish, and food. Major general population exposure will occur through consumption of food including consumption of fish from water bodies that have high levels of dieldrin.

Average Daily Intake: AIR INTAKE (assuming air concn 0.002-0.02 ppt and 20 m³/day air inhalation) 0.0006-0.006 ug/day. WATER INTAKE (assuming drinking water concn 0-0.07 ppt and 2 L/day water consumption) 0-0.00014 ug/day. FOOD INTAKE 1971-1976, 3 ug/day avg [22]. U.S. dietary intake (ng/kg body wt/day) for different age and sex group in 1982-1984- 6-11 months, 10.1; 2 yr, 15.9; 14-16 female, 5.8; 14-16 male, 7.5; 25-30 female, 5.6; 25-30 male, 6.8; 60-65 female, 5.2; 60-65 male, 5.6 [37]. Estimated daily dietary intake (ng) from different Canadian food composites in 1985- fruit, 5.2; leafy veg., 260; root veg., 1875; milk, 123; egg/meat, 510 [20].

Occupational Exposures: Estimated intake to occupationally exposed workers- 0.72 to 1.10 mg/man/day compared to 0.025 mg/man/day for general population [42]. Estimated potential exposure during orchard spraying- 14.2 to 15.5 mg/hr for dermal and 0.03 to 0.25 mg/hr for inhalation [42]. Whole blood concn in wine growers- 0.02-1.19 ug/L (range), 0.21 ug/L (median); normal group- 0.01-0.38 ug/L (range for 1977), 0.09 (median for 1977), 0.02-0.93 (range for 1982), 0.09 (median for 1982) [7].

Body Burdens: HUMAN MILK - mainland USA 102 samples, 91.2% pos, 0.062 ppm lipid basis, mean; Hawaii 54 samples, 94.4% pos, 0.042 ppm, mean [89]; Canada, 16 samples, 1.0-1.8 ppb whole milk [59]. Alberta, Canada 1966-70 - 59 samples, 39% pos, 0.180 ppm lipid basis, mean, 1977-78 - 33 samples 97% pos, 0.025 ppm, mean [19] USA 1975 1436 samples, 80% pos, 0.16-0.44 ppm milk fat [45] Various countries 0.009-3.78 ppm milk fat [45]. Germany, 0.02 ppm avg [75] HUMAN FAT - Various countries 1971-77 0.069-0.29 ppm [1]. BLOOD - Canadian, maternal, during lactation, trace-0.2 ppb [59].

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REFERENCES

1. Abbott DC et al; Brit Med J 283: 1425-8 (1981)
2. Atlas E, Giam CS; Water Air Soil Pollution 38: 19-36 (1988)
3. Atlas E, Giam CS; Science 211: 163-5 (1981)
4. Atlas E et al; Environ Sci Technol 16: 283-6 (1982)
5. Battersby NG, Wilson V; Appl Environ Microbiol 55: 433-39 (1989)
6. Becker PH, Sperveslage H; Bull Environ contam Toxicol 42: 721-27 (1989)
7. Bertram HP et al; Hexachlorobenzene content in human whole blood and adipose tissue: Experiences in environmental specimen banking In: Hexachlorobenzene: Proc Internatl Symp IARC Publication 77, Lyon pp 173-82 (1986)
8. Biberhofer J, Stevens RJ; Organochlorine Contaminants In Ambient Waters of Lake Ontario Sci Ser 159 Inland Waters/Lands Directorate, Burlington, Canada (1987)
9. Bidleman TF et al; J Mar Res 39: 443-64 (1981)
10. Bidleman TF; Atmos Environ 15: 619-24 (1981)
11. Briggs GG et al; J Agric Food Chem 29: 1050-9 (1981)
12. Butler PA, Schutzmann RL; Pestic Monit J 12: 51-9 (1978)
13. Callahan MA et al; Water-Related Fate of 129 Priority Pollutants pp 26-1 to 26-12 USEPA 440/4-79-029a (1979)
14. Carey AE et al; Pestic Monit J 13: 17-22 (1979)
15. Carey AE et al; Pestic Monit J 12: 209-29 (1979)
16. Castro TF, Yoshida T; J Agric Food Chem 19: 1168-70 (1971)
17. Clark DR Jr et al; Environ Toxicol Chem 2: 387-93 (1983)
18. Crosby DG, Moilanen KW; Arch Environ Contam Toxicol 2: 62-74 (1974)
19. Currie RA et al; Pestic Monit J 13: 52-5 (1979)
20. Davies K; Chemosphere 17: 263-76 (1988)
21. DeVault DS et al; J Great Lakes Res 14: 23-33 (1988)
22. Duggan RE et al; Pesticide Residue Levels in Foods in the US from July 1, 1969 to June 30, 1976 FDA and AOAC (1983)
23. Eichelberger JW, Lichtenberg JJ; Environ Sci Technol 5: 541-4 (1971)
24. Eisenreich SJ; Environ Sci Technol 15: 30-8 (1981)
25. El-Beit IOD et al; Inter J Environ Stud 16: 189-96 (1981)
26. Ellington JJ et al; Measurement of Hydrolysis Rate Constant for Evaluation of Hazardous Waste Land Disposal, vol 3. Data on 70 Chemicals USEPA/66/3-88/028 NTIS PB 88-234042 (1988)
27. Elliott JE et al; Environ Monit Assess 12: 67-82 (1989)
28. Ellis DL et al; Bull Environ Contam Toxicol 42: 57-64 (1989)
29. FDA; Food and Drug Administration Pesticide Program. Residues in Foods-1988 Washington DC (1989)
30. Foley RE, Batcheller GR; J Wildl Manage 52: 441-45 (1988)
31. Frank R; Arch Environ Contam Toxicol 12: 641-54 (1983)
32. Frank R et al; J Environ Qual 11: 497-505 (1982)
33. Freitag D et al; Chemosphere 14: 1589-616 (1985)

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34. Gaskin DE et al; Arch Environ Contam Toxicol 7: 505-13 (1978)
35. Gile JD, Gillett JW; J Agric Food Chem 27: 1159-64 (1979)
36. Gregor DJ, Gummer WD; Environ Sci Technol 23: 561-65 (1989)
37. Gunderson EL; J Assoc Off Anal Chem 71: 1200-9 (1988)
38. Hansch C, Leo AJ; Medchem Project Issue No.26 Claremont, CA: Pomona College (1985)
39. Helling CS; Soil Sci Soc Amer Proc 35: 737-43 (1971)
40. Hundley HK et al; J Assoc Off Anal Chem 71: 875-92 (1988)
41. Hunter RG et al; Pestic Monit J 14: 102-7 (1980)
42. IARC; Some Organochlorine Pesticides 5: 125-56 (1974)
43. Isnard P, Lambert S; Chemosphere 17: 21-34 (1988)
44. Ivie GW, Casida TE; Science 167: 1620-22 (1970)
45. Jensen AA; Residue Res 89: 1-128 (1983)
46. Jury WA et al; J Environ Qual 16: 422-28 (1987)
47. Kaiser KLE; Can J Fish Aquat Sci 39: 571-9 (1982)
48. Keith LH et al; pp 329-73 in Identification and Analysis of Organic Pollutants in Water. Keith LH ed. Ann Arbor Press, Ann Arbor MI (1976)
49. Kirk PW, Lester JN; Wat Sci Tech 20: 353-59 (1988)
50. Konasewich D et al; Status Report on Organic and Heavy Metal Contaminants in the Lakes Erie, Huron and Superior basins. p 273 Great Lakes Qual Board (1978)
51. Law LJ et al; Marine Pollut Bull 20: 110-5 (1989)
52. Lee RE Jr; 4th Int Clean Air Congr Proc Kasuga S et al eds pp 37-40 (1977)
53. Lewis RG et al; APCA Annu Meet 79th, Minneapolis, MN June 22-27 (1986)
54. Luke MA et al; J Assoc Off Anal Chem 71: 415-20 (1988)
55. Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds McGraw-Hill NY (1982)
56. Matsumura F et al; Science 170: 1206-7 (1970)
57. Mattraw HC Jr; Pestic Monit J 9:106-114 (1975)
58. Maule A et al; Pestic Biochem Physiol 27: 229-36 (1987)
59. Mes J et al; Arch Environ Contam Toxicol 13: 217-23 (1984)
60. Metcalf RL et al; Environ Health Perspect. 1973 No. 4: 35-44 (1973)
61. Muir DCG et al; Environ Sci Technol 22: 1071-79 (1988)
62. Nash RG, Woolson EA; Science 157: 924-7 (1967)
63. Ohlendorf HM et al; Pestic Monit J 14: 125-35 (1981)
64. Page GW; Environ Sci Technol 15: 1475-81 (1981)
65. Pearce PA et al; Environ Pollut 56: 217-35 (1989)
66. Peterman PH et al; pp 145-60 in Hydrocarbons and Halogenated Hydrocarbons in the Aquatic Environment Afghan BK, Mackay D eds, New York, NY, Plenum Press (1980)
67. Reish DJ et al; J Water Pollut Control Fed 54: 786-812 (1982)
68. Reish DJ et al; J Water Pollut Control Fed 53: 925-49 (1981)
69. Roberts JW, Camann DE; Bull Environ Contam Toxicol 43: 717-24 (1989)
70. Roseboom DP et al; Effect of Agriculture on Cedar Lake Water Quality. Illinois State Water Survey ISWS/CIR-138/79 (1979)
71. Rosewell KT et al; Pestic Monit J 12: 189-92 (1979)

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72. Sanborn JR et al; The Degradation of Selected Pesticides in Soil: A Review of the Published Literature USEPA 600/9-77-022 (1977)
73. Sanborn TR, Yu C-C; Bull Environ Contam Toxicol 10: 340-6 (1973)
74. Sandu SS et al; J Amer Water Works Assoc 70: 41-5 (1978)
75. Schecter A et al; Chemosphere 19: 913-18 (1989)
76. Schmitt CJ; Pestic Monit J 14: 136-206 (1981)
77. Schnoor JL et al; Verification of a Toxic Organic Substance Transport and Bioaccumulation Model USEPA 600/3-83-007 (1983)
78. Sharom MS et al; Water Res 14: 1089-93 (1980)
79. Smith JA et al; Bull Environ Contam Toxicol 39: 465-73 (1987)
80. Smith JH et al; Environmental Pathways of Selected Chemicals in Freshwater Systems Part I Background and Experimental Procedures USEPA 600/7-77-113 (1977)
81. Spalding RF et al; Pestic Monit J 14: 70-3 (1980)
82. Stanley CW et al; Environ Sci Technol 5: 430-5 (1971)
83. Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)
84. Strachan WMJ; Environ Toxicol Chem 4: 677-83 (1985)
85. Sumner CE; Pestic Monit J 12: 87-90 (1978)
86. Suintio LR et al; Rev Environ Contam Toxicol 103: 1-59 (1988)
87. Swain WR; J Great Lakes Res 4: 398-407 (1978)
88. Tabak HH et al; J Water Poll Control Fed 53: 1503-18 (1981)
89. Takei GH et al; Bull Environ Contam Toxicol 30: 606-13 (1983)
90. Thibodeaux LJ, Hwang ST; Environ Progress 1: 42-6 (1982)
91. Travis CC, Arms AD; Environ Sci Technol 22: 271-74 (1988)
92. Trotter WJ et al; J Assoc Off Anal Chem 72: 501-3 (1986)
93. USEPA; Ambient Water Quality Criteria for Aldrin/Dieldrin USEPA 440/5-80-019 (1980)
94. USEPA; Treatability Manual p I.13.9-3 USEPA 600/2-82-001a (1981)
95. Warner HP et al; Determination of Henry's Law Constants of Selected Priority Pollutants, EPA/600/D-87/229 NTIS PB87-212684 (1987)
96. Wegman RCC, Greve PA; pp 405-45 in Hydrocarbons and Halogenated Hydrocarbons in the Aquatic Environment. Plenum Press, NY (1980)
97. White DH; Pestic Monit J 12: 193-7 (1979)
98. Wiemeyer SN et al; Estuaries 3: 155-67 (1980)

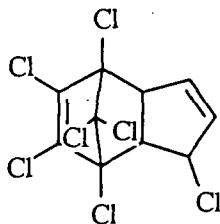
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Heptachlor

Summary: The use of heptachlor in the United States was restricted to the control of termites in 1983 and its release to the environment will result from this use. Release of heptachlor to soil surfaces will result in volatilization from the surface, especially in moist soils, but volatilization of heptachlor incorporated into soil will be slower. Hydrolysis in moist soils is expected to be significant. In soil, heptachlor will degrade to 1-hydroxychlordehene, heptachlor epoxide and an unidentified metabolite less hydrophilic than heptachlor epoxide. Biodegradation may also be significant. Heptachlor is expected to adsorb strongly to soil and, therefore, to resist leaching to ground water. Release of heptachlor to water will result in hydrolysis to 1-hydroxychlordehene (half-life of about 1 day) and volatilization. Adsorption to sediments may occur. Biodegradation of heptachlor may occur, but is expected to be slow compared to hydrolysis. Bioconcentration of heptachlor may be significant. Direct and photosensitized photolysis may occur but are not expected to occur at a rate comparable to that of hydrolysis. In air, vapor phase heptachlor will react with photochemically generated hydroxyl radicals and ozone with estimated half-lives of 6 and 1.5 hours, respectively. Direct photolysis may also occur.

Natural Sources:

Artificial Sources: As of 1983, the use of heptachlor as an insecticide has been restricted to termite control [38]. Based on monitoring data, mean loadings of heptachlor in treated wastewater in kg/day were coal mining, 0.0081; foundries, 0.030 and nonferrous metals manufacturing, 0.0008 [80]. Total loading of heptachlor to Lake Ontario from the Niagara River were less than 83 kg/yr, less than 79 kg/yr, and less than 79 kg/yr in 1980, 1981, and 1982, respectively [44].

Terrestrial Fate: The half-life of heptachlor in soil was calculated to range from 0.4 to 0.8 years based on data collected in Mississippi, New Jersey and Beltsville, MD [1]. The mean disappearance rates of heptachlor from soil ranged from 5.25 to 79.5% per year, depending upon the soil type and mode of application of the insecticide [69]. The highest rate was observed in sandy soil following an application of a granule formulation. Soil incorporation also led to rapid disappearance rates in all soil types [69]. A water emulsion of heptachlor was applied to soils from six states and quantified initially and after 12 months. The results listed

by state were: Hawaii, 81 ppm; Oregon, 11 ppm. In soil, heptachlor epoxide and heptachlor epoxide [56] therefore, residues on surfaces, especially into the soil. Soils is expected especially in

Aquatic Fate: Heptachlor in water receives about 75% of the 100% degradation be the predominant in unbuffered water [20]. Biocorrelation unadsorbed heptachlor coefficient, heptachlor may also be compared to

Atmospheric Fate: Heptachlor is expected to be degraded in the atmosphere by hydroxyl radicals. The rate constant for the reaction produced hydroxyl radicals is 1.5×10^{-11} cm³/molecule of about 6 hours. Hydroxyl radicals per cm³ of heptachlor will be 1.5×10^{-11} cm³/molecule of about 1.5 hours per cm³ [7]. In the vapor phase. The low

Heptachlor

by state were: Arkansas, 746 to 117 ppm; Florida, 841 to 93 ppm; Hawaii, 817 to 77 ppm; Maryland, 775 to 122 ppm; Missouri, 758 to 103 ppm; Oregon, 741 to 156 ppm; and South Carolina, 774 to 62 ppm [18]. In soil, heptachlor will degrade to 1-hydroxychlorde, heptachlor epoxide and an unidentified metabolite less hydrophilic than heptachlor epoxide [56]. Heptachlor is expected to adsorb strongly to soil and, therefore, resist leaching to ground water. Volatilization from soil surfaces, especially wet ones, will be significant. Heptachlor incorporated into the soil will resist volatilization. Hydrolysis of heptachlor in moist soils is expected to be significant. Biodegradation may be important, especially under anaerobic conditions.

Aquatic Fate: A river die-away laboratory test was conducted with heptachlor in raw water from the Little Miami River in Ohio. The river receives domestic and industrial wastes and farm runoff. After 1 week, 75% of the initial heptachlor had disappeared and the heptachlor was 100% degraded after 2 weeks [26]. Chemical hydrolysis is expected to be the predominant fate of heptachlor in water, with half-lives of 23.1 h in unbuffered water [16] and 4.48 days at pH 7 in 99:1 water:ethanol [20]. Bioconcentration in fish may also occur and volatilization of unadsorbed heptachlor may be significant. Due to its high soil/sorption coefficient, heptachlor is expected to adsorb to sediments. Biodegradation may also be significant, but is expected to occur relatively slowly compared to hydrolysis.

Atmospheric Fate: Based upon the vapor pressure, heptachlor is expected to exist almost entirely in the vapor phase in ambient air [27]. In the atmosphere, vapor phase reactions with photochemically produced hydroxyl radicals and ozone may be important fate processes. The rate constant for the vapor-phase reaction of heptachlor with photochemically produced hydroxyl radicals has been estimated to be 6.57×10^{-11} cm³/molecule-sec at 25 °C, which corresponds to an atmospheric half-life of about 6 hours at an atmospheric concentration of 5×10^5 hydroxyl radicals per cm³ [8]. The rate constant for the vapor-phase reaction of heptachlor with ozone has been estimated to be less than 2.0×10^{-16} cm³/molecule-sec at 25 °C which corresponds to an atmospheric half-life of about 1.5 hours at an atmospheric concentration of 7×10^{11} molecules per cm³ [7]. In addition, heptachlor may directly photolyze in the vapor phase. The low water solubility and the short atmospheric residence time

Heptachlor

of heptachlor indicates that physical removal from air by wet deposition (rainfall and dissolution in clouds, etc.) is of limited importance.

Biodegradation: The products resulting from the incubation of heptachlor with a mixed culture of soil microorganisms were chlordene(7%), 1-exohydroxychlordene, heptachlor epoxide (<0.04%) and chlordene epoxide (<0.02%) which were formed after 2 weeks [57]. Biodegradation of heptachlor by soil microorganisms produced heptachlor epoxide and chlordene [58]. Mixed cultures of Pseudomonas sp. in water were capable of growing on heptachlor [14]. The products were chlordene, 1-hydroxy-2,3-epoxychlordene and heptachlor epoxide [14]. When heptachlor was aerobically incubated with acclimated, mixed microbial cultures, an average of 95.3% of the initial heptachlor was removed in 4 weeks [46]. The biodegradation of 1 mg/L heptachlor was said to occur immediately [46]. Anaerobic incubation of 10 ppm heptachlor with thick sludge at 53 °C resulted in complete degradation in about 1 day [39]. Degradation of heptachlor in flooded Casiguran sandy loam (1 month) and Luisiana clay (2 months) was complete (initial level about 13 ppm) and nearly complete in Maahas clay (3 months) [19]. In Pila clay loam, degradation proceeded to only about 5 ppm from the initial level of about 13 ppm after 3 months [19].

Abiotic Degradation: The, first order hydrolysis rate constant of heptachlor is 0.03 hr^{-1} at 29.88°C [16]. This corresponds to a half-life of 23.1 hr. The hydrolysis product is 1-hydroxychlordehene [16]. The hydrolysis half-lives of heptachlor in a series of 99:1 water:ethanol phosphate buffers were 5.39, 4.34, 4.48, 4.48, and 3.01 days at pH values of 4.5, 5.0, 6.0, 7.0, and 8.0, respectively [20]. Heptachlor absorbs UV light weakly above 290 nm [32] and thin films of heptachlor have been shown to undergo direct photolysis when exposed to sunlight and artificial light sources $>290 \text{ nm}$ [16]. The products were two dechlorinated photoproducts and heptachlor epoxide [16]. Heptachlor at 1.35×10^{-7} to $1.0 \times 10^{-5} \text{ M}$ irradiated for $>180 \text{ min}$ at $>290 \text{ nm}$ degraded by about 5 to 10% [53]. Photoheptachlor was the photoproduct [53]. Heptachlor also undergoes photosensitized photolysis in the presence of benzophenone [16]. Heptachlor is converted to its corresponding photoisomer and several minor products on exposure to low intensity (longwave) UV light [66]. This photolysis can also take place on plant leaves in presence of sunlight or UV light [66]. Under conditions of

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sunlight or ultraviolet light, heptachlor, 1-exo-hydroxychlorde, or 1-4,5,6,7,8,8-hexachloro-3a,4,7,7a-tetrahydro-4,7-methanionden-1-ol was photodegraded forming a cyclic ketone 1,1a,2,2,3-exo-6-hexachloro-1a,2,3,3a,5a,5b-hexahydro-1,3-methano-1H-cyclobuta(cd)pentalen-4-one [65]. Direct and photosensitized photolysis of unadsorbed heptachlor may, therefore, occur in the environment. The rate constant for the vapor-phase reaction of heptachlor with photochemically produced hydroxyl radicals has been estimated to be $6.57 \times 10^{-11} \text{ cm}^3/\text{molecule-sec}$ at 25°C , which corresponds to an atmospheric half-life of about 6 hours at an atmospheric concentration of 5×10^5 hydroxyl radicals per cm^3 [8]. The rate constant for the vapor-phase reaction of heptachlor with ozone has been estimated to be less than $2.0 \times 10^{-16} \text{ cm}^3/\text{molecule-sec}$ at 25°C which corresponds to an atmospheric half-life of about 1.5 hours at an atmospheric concentration of 7×10^{11} molecules per cm^3 [7].

Bioconcentration: Leiostomus xanthurus (spot) was exposed to technical heptachlor for a duration of 24 days and exhibited a whole body bioconcentration factor ranging from 5,744 to 8,282 [71]. Edible tissue from the same organism exhibited a bioconcentration factor of 4,686 for the same duration of time. The initial concentration of heptachlor was not specified [71]. Pimephales promelas (fathead minnow) was exposed to heptachlor for 32 days and exhibited a bioconcentration factor of 9,500 [83]. Bioconcentration factors (BCF) of heptachlor are 3,800 in mosquito fish [16], 3,600 for a 72 hour test, 7,400 for a 96 hour test in spot [16], 21,379 in sheepshead minnows [89], 19,952 in fathead minnows [89] and 17,400 in an unidentified fish species [41]. The BCFs of heptachlor in snails, alga and oysters are 37,000 [16] and 21,000 [16], and 18,000 [11], respectively. Bioconcentration may be limited, however, by the rapidity of heptachlor hydrolysis to 1-hydroxychlorde and the adsorption of heptachlor to sediments [16].

Soil Adsorption/Mobility: Heptachlor is considered to be a moderately persistent compound, with a half-life of 6 months in the soil [79]. Heptachlor was added to soil columns containing Hagerstown silty clay loam and Lakeland sandy loam which were then subjected to the upward movement of water at an undisclosed rate [36]. After 3 days, all the heptachlor was detected at the initial column depth, indicating no tendency to leach in these soils [36]. The log soil-sorption coefficient (Koc) of heptachlor was estimated to be 4.48 [41]. Based on this value,

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strong adsorption of heptachlor to soil is expected and heptachlor should not extensively leach to ground water [41].

Volatilization from Water/Soil: **WATER:** The volatilization half-life of heptachlor from aquatic media is estimated to be 2 to 10 days from pond, river, and lake water [78]. Estimates indicate the evaporative half-life of heptachlor in aquatic media appears to be longer than that of 1 to 2 days for chlordane [78]. The Henry's Law constant was used to estimate the volatilization half-lives of heptachlor from model streams, rivers and lakes. The wind velocity was assumed to be 3 m/s. The current velocities of the streams, rivers and lakes were assumed to be 2, 1, and 0.01 m/s, respectively, the depths of the streams and rivers 1 m and that of the lakes 50 m. The estimated volatilization half-lives were 3.376 hr, 6.252 hr and 6780.4 hr (282 days) for the streams, rivers and lakes, respectively [51]. It should be noted that these values apply strictly to dissolved heptachlor and that any process such as adsorption to sediments which limits the amount of dissolved heptachlor will increase these half-lives. **SOIL:** Fifty hours following the application of heptachlor to a dry soil surface, 14 to 40% of the heptachlor had volatilized and 6 h and 6 days after application of heptachlor to a moist soil surface, 50% and 90% of the heptachlor had volatilized, respectively [31]. Only 7% of heptachlor incorporated 7.5 cm into soil, however, had volatilized after 167 days [31].

Water Concentrations: **SURFACE WATER:** Of the 4650 stations reporting heptachlor in ambient water in EPA's STORET database, 34.0% contained detectable levels of the chemical with a median concentration of 0.001 ug/L [76]. Heptachlor was listed as a contaminant of the Great Lakes including Lakes Ontario, Erie, Huron, Michigan and Superior [33]. In 1980, heptachlor was detected in the waters of Lake Pontchartrain Inner Harbor Navigation Canal at a concentration of 0.6 ng/L at an ebb tide of 1.5 m and at concentrations ranging from 9.1 to 9.3 ng/L at flood tides of 1.5 to 10 m [55]. Heptachlor was detected with a 21.4% frequency of occurrence for 604 samples of surface waters from New Jersey collected from 1977 to 1979 [64]. Heptachlor was detected in Mississippi River water at Louisiana at concentrations ranging from undetected levels to 2.4 ng/L for the summer to winter of 1974 [15]. Heptachlor was detected in Shatt al-Arab River, Iraq at concentrations ranging from 2 to 19 ng/L with respective mean and median

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concentrations of 10 and 9 ng/L and with a 100% frequency of occurrence [23]. At a second sampling location, heptachlor was detected in Shatt al-Arab River, Iraq at concentrations ranging from 50 to 91 ng/L with respective mean and median concentrations of 79 and 76 ng/L and with a 100% frequency of occurrence [23]. Heptachlor was detected in Tigris River, Iraq at concentrations ranging from 10 to 39 ng/L with respective mean and median concentrations of 19 and 17 ng/L and with a 100% frequency of occurrence [23]. Heptachlor was detected in Euphrates River, Iraq at concentrations ranging from undetected levels to 7 ng/L with respective mean and median concentrations of 4 and 3 ng/L and with a 70% frequency of occurrence [23]. Heptachlor was detected in suspended particulate matter of the Shatt al-Arab River, Iraq at concentrations ranging from 48 to 83 ng/L with respective mean and median concentrations of 68 and 55 ng/L and with a 100% frequency of occurrence [23]. At a second sampling location, heptachlor was detected in suspended particulate matter of the Shatt al-Arab River, Iraq at concentrations ranging from 153 to 204 ng/L with respective mean and median concentrations of 186 and 164 ng/L and with a 100% frequency of occurrence [23]. Heptachlor was detected in suspended particulate matter of the Tigris River, Iraq at concentrations ranging from 555 to 804 ng/L with respective mean and median concentrations of 679 and 651 ng/L and with a 100% frequency of occurrence [23]. Mediterranean waters off the coast of Morocco contained heptachlor at concentrations ranging from trace quantities to 11 ppb, trace quantities to 100 ppb and trace quantities to 3 ppb with mean concentrations of 5, 20 and 2 ppb for 8 samples each collected during the autumn, winter and spring, respectively [42]. Throughout 1982, surface waters of the Donana National Park, Spain contained heptachlor at concentrations ranging from 0.002 to 0.006 ppb [67]. GROUND WATER: Heptachlor was detected with a 21.2% frequency of occurrence and a maximum concentration of 1.0 ppb for 1,075 samples of ground water from New Jersey collected from 1977 to 1979 [64]. Heptachlor was detected but not quantified in ground water samples in New Jersey [35], California [21] and from northern Italy [9]. According to the EPA's Pesticides in Ground Water Database, heptachlor was detected in the ground water supplies of the states of Kansas and Idaho at median concentrations of 0.03 and 0.02 ppb, respectively [88]. During the 1978 irrigation season, 14 ground water samples were collected in the central plateau region of Nebraska, an area known to have high nitrate-nitrogen levels, and were analyzed for

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the presence of 13 residues. Levels of the organochlorine insecticide, heptachlor and its derivative, heptachlor epoxide, were all below the detectable limits of 0.005 to 0.010 ug/L [73]. Heptachlor and heptachlor epoxide have been detected in private drinking wells at concentrations less than 0.02 ug/L [79].

Effluent Concentrations: Of the 671 stations reporting heptachlor in industrial effluents in EPA's STORET database, 3.0% contained detectable levels of the chemical with a median concentration of less than 0.007 ug/L [76]. Heptachlor residues were detected in 47 samples of treated wastewater effluent from coal mining industries at a mean concentration of 2.2 ug/L with a frequency of occurrence of 4.3% [82]. Heptachlor residues were detected in 11 samples of treated wastewater effluent from foundries at concentrations ranging from 5 to 31 ug/L with a mean concentration of 8.7 ug/L with a frequency of occurrence of 100% [82]. Heptachlor residues were detected in 55 samples of treated wastewater effluent from nonferrous manufacturers at concentrations ranging from undetected levels to 0.7 ug/L with a mean concentration of 0.1 ug/L [82]. Heptachlor was detected in leachate from the Love Canal hazardous waste site at concentrations less than 10 ug/L [84].

Sediment/Soil Concentrations: SOIL: Heptachlor was detected in soil of Bakersfield, CA at a range in concentrations of 0.02 to 0.10 ppm and an average of less than 0.01 ppm, with a frequency of occurrence of 4% [87]. Heptachlor was detected in soil of Houston, TX at a range in concentrations of 0.01 to 0.02 ppm and an average of less than 0.01 ppm, with a frequency of occurrence of 6% [87]. Heptachlor was detected in soil of Manhattan, KN at a range in concentrations of 0.02 to 0.09 ppm and an average of less than 0.01 ppm, with a frequency of occurrence of 10% [87]. Heptachlor was detected in soil of Miami, FL at a range in concentrations of 0.01 to 0.20 ppm and an average of less than 0.01 ppm, with a frequency of occurrence of 6% [87]. Heptachlor was detected in soil of Milwaukee, WI at a range in concentrations of 0.02 to 0.45 ppm and an average of 0.02 ppm, with a frequency of occurrence of 12% [87]. Heptachlor was detected in soil of Salt Lake, UT at a range in concentrations of 0.01 to 0.24 ppm and an average of 0.01 ppm, with a frequency of occurrence of 12% [87]. Heptachlor was detected in soil of Waterbury, CN at a range in concentrations of 0.01 to 0.53 ppm and an average of 0.01 ppm, with a frequency of occurrence of 8% [87]. All the

samples were from not before 1966 and 1967 soils on the shown to contain levels to 0.01 heptachlor in detectable levels ug/kg [76]. 1 from Niagara and median of Heptachlor at Lawrence River sediments from than 0.1, 0.2. Inlet, Drury Creek, respectively the Shatt al-Baghdadi ng/L with residues and with a 10 in surface sediments ranging from concentration [23].

Atmospheric ambient air concentration was also detected to 15, 1983 [19] 9 homes in Jacksonville, FL ug/m³ with a Heptachlor was Heptachlor was mean concentration concentration was 6.3 ng/m³ in air above the ground periods of 3

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samples were collected in 1969 [87]. Heptachlor concentrations ranged from not being detected to 0.40 ppm in soil samples collected in 1964, 1966 and 1969 from 16 farms in southwestern Ontario [37]. Agricultural soils on the North Coast Region of New South Wales, Australia were shown to contain heptachlor at concentrations ranging from undetected levels to 0.06 ppm [54]. **SEDIMENTS:** Of the 1665 stations reporting heptachlor in sediments in EPA's STORET database, 26.0% contained detectable levels of the chemical with a median concentration of 0.1 ug/kg [76]. From 1979 to 1981, heptachlor was detected in sediments from Niagara-on-the-Lake with an 8% frequency of occurrence and mean and median concentrations of 1 and less than 1 ng/g, respectively [44]. Heptachlor concentrations in all sediment samples collected from the St. Lawrence River were less than 1 ug/kg [33]. Heptachlor was detected in sediments from Manukau Harbor, New Zealand at concentrations of less than 0.1, 0.2, 0.4, 0.6 and 0.4 ng/g for sampling points located at Waiuku Inlet, Drury Creek, Pukaki Creek, Mangere Inlet and Big Muddy Creek, respectively [30]. Heptachlor was detected in surface sediments of the Shatt al-Arab River, Iraq at concentrations ranging from 13 to 48 ng/L with respective mean and median concentrations of 24 and 19 ng/L and with a 100% frequency of occurrence [23]. Heptachlor was detected in surface sub-sediments of the Tigris River, Iraq at concentrations ranging from 2 to 15 ng/L with respective mean and median concentrations of 9 and 7 ng/L and with a 100% frequency of occurrence [23].

Atmospheric Concentrations: **URBAN:** Heptachlor was detected in the ambient air of Iowa City, IA and Orlando, FL and at average concentrations of 19.2 ng/m³ and 2.3 ng/m³, respectively [75]. Heptachlor was also detected in the air of Stockholm, Sweden between October 13 to 15, 1983 [12]. Heptachlor was detected in the ambient air outside 5 of 9 homes in Jacksonville, FL at concentrations ranging from 0.009 to 0.059 ug/m³ with a mean concentration of 0.025 ug/m³ [47]. **SUBURBAN:** Heptachlor was detected in a study of suburban areas in 1976 [78]. Heptachlor was found to be widespread in ambient air, with a typical mean concentration on the order of 0.5 ng/m³ [78]. The average air concentration of heptachlor in the community with the highest reading was 6.3 ng/m³ [78]. **SOURCE DOMINATED:** The amount of heptachlor in air above treated fields was measured to be as high as 16 ng/m³ for periods of 3 weeks after treatment [78]. In 1970, 1971 and 1972,

Heptachlor

heptachlor was detected in 32, 54 and 46 of 66, 60 and 64 air samples collected within 800 m of two pesticide formulation facilities in Arkansas at concentrations ranging from 0.4 to 2.4, 0.3 to 2.9 and 0.3 to 1.8 ng/m³ with mean concentrations of 1.2, 1.1 and 1.0 ng/m³ [48]. INDOOR: A study of the indoor air of four houses in Bloomington, IN that were treated with termiticide showed heptachlor with a 100% frequency of occurrence [6]. Three of 4 homes had greater concentrations of heptachlor in the basements than in the upstairs portions of the house [6]. Upstairs air concentrations ranged from 2.6 to 66 ng/m³, whereas basement atmospheres contained heptachlor at concentrations of 4.3 to 110 ng/m³ [6]. Heptachlor was detected in the ambient air within 7 of 9 homes in Jacksonville, FL at concentrations ranging from 0.012 to 0.36 ug/m³ with a mean concentration of 0.18 ug/m³ [47]. Heptachlor was detected in the ambient air of the living areas of 12 homes in New Jersey before, 1 week, 3 months and 1 year after treatment for termite control at concentrations ranging from undetectable levels to 0.21, undetectable levels to 0.94, undetectable levels to 0.64 and undetectable levels to 0.57 ug/m³ with mean concentrations of 0.04, 0.14, 0.15 and 0.13 ug/m³ and with frequencies of occurrence of 57, 86, 77 and 81%, respectively [49]. Heptachlor was detected in the ambient air of the non-living areas of 12 homes in New Jersey before, 1 week, 3 months and 1 year after treatment for termite control at concentrations ranging from undetectable levels to 0.51, undetectable levels to 5.92, undetectable levels to 3.88 and undetectable levels to 3.89 ug/m³ with mean concentrations of 0.12, 1.02, 0.69 and 0.88 ug/m³ and with frequencies of occurrence of 67, 77, 93 and 100%, respectively [49].

Food Survey Values: Heptachlor and heptachlor epoxide combined were detected at an average concentration of 0.1 ppb with a frequency of detection of 0.4% among 784 samples of domestic cheese [25]. Heptachlor and heptachlor epoxide combined were detected at average concentrations of less than 0.1 ppb and 0.6 ppb with frequencies of detection of 0.4% and 0.2% among 2,954 and 4,117 samples of domestic and imported vine and ear vegetables, respectively [25]. For 947 samples of domestic whole grains, the average heptachlor and heptachlor epoxide combined concentration was less than 0.1 ppb with a frequency of occurrence of 0.2% [25]. Heptachlor and heptachlor epoxide combined were detected at average concentrations of 126 ppb and 40 ppb with ranges from 40 to 50 ppb and trace quantities to 19,000 ppb, and with a

frequency of soybeans, and heptachlor epoxide [25]. For 15, and heptachlor epoxide of 16 and 13 respectively detected at a 1980 upon soil 1 of 11 and Soconusco, Comarca Lagunera heptachlor epoxide units [3]. He collected between mean concentration 0.01 to 0.03 ng India from concentration for radish; 1 cauliflower; 1 brinjal; 1 ug/ tomato; 389 u smooth gourd ug/kg for chili FDA Los Angeles domestic and [50]. Heptachlor ppm and once

Plant Concentration

Fish/Seafood concentration among 2,901 an average concentration detection of 0. detected in fish at the Astabula

Heptachlor

frequency of detection of 3.6% and 1.9% among 280 and 104 samples of soybeans, and corn and corn products, respectively [25]. Heptachlor and heptachlor epoxide were infrequently found in leaf and stem vegetables [25]. For 15,200 and 11,340 samples of red meat and poultry, heptachlor and heptachlor epoxide combined were detected at average concentrations of 16 and 13 ppb with frequencies of occurrence of 20.7% and 16.5%, respectively [25]. Heptachlor and heptachlor epoxide combined were detected at average concentrations of 5.3 ppb in 1974 and 6.6 ppb in 1980 upon soybeans grown in Illinois [52]. Heptachlor was detected in 1 of 11 and 3 of 10 cheese samples from Comarca Lagunera and Soconusco, Mexico [3]. Just over 50% of the chicken's eggs from Comarca Lagunera, Mexico also contained heptachlor [3]. Average heptachlor concentrations in cheese and eggs were reported, but without units [3]. Heptachlor was detected in 16 of 105 chicken fat samples collected between April 1980 and February 1982 in Kenya [40]. The mean concentration was less than 0.01 mg/kg and the range was from 0.01 to 0.03 mg/kg [40]. For vegetables surveyed in the markets of Delhi, India from August 1984 to January 1986, the average heptachlor concentrations were 12 ug/kg for potato; 4 ug/kg for colocasia; 20 ug/kg for radish; 15 ug/kg for onion; 4 ug/kg for cabbage; 2 ug/kg for cauliflower; 1 ug/kg for coriander; 21 ug/kg for spinach; 23 ug/kg for brinjal; 1 ug/kg for ladyfinger; 1 ug/kg for french beans; 4 ug/kg for tomato; 389 ug/kg for green peas; 23 ug/kg for bottle gourd; 2 ug/kg for smooth gourd; 2 ug/kg for bitter gourd; 10 ug/kg for cucumber; and 42 ug/kg for chilies [45]. During a 5 year period from 1982 to 1986, The FDA Los Angeles District Laboratory analyzed 19,851 samples of domestic and imported food and feed commodities for pesticide residues [50]. Heptachlor was detected 3 times at concentrations less than 0.05 ppm and once at a concentration between 0.05 and 0.10 ppm [50].

Plant Concentrations:

Fish/Seafood Concentrations: Heptachlor was detected at an average concentration of 0.0002 ppm with a frequency of detection of 0.3% among 2,901 samples of domestic fish [25]. Heptachlor was detected at an average concentration less than 0.0001 ppm with a frequency of detection of 0.4% for 361 samples of imported fish [25]. Heptachlor was detected in fish collected from Great Lake harbors and tributary mouths at the Astabula and Black Rivers, Ohio; Sheboygan, Memonimee.

Heptachlor

Kinnickinnic, Fox and Wolf Rivers, Wisconsin; and Chequamegon Bay, Lake Superior, Wisconsin at concentrations less than 0.002 mg/kg [22]. Heptachlor was detected in Jack fish (*Seriola lalandi*) collected from the Chilean coast at an average concentration of 900 ppb [63]. Shrimp (*Penaeus setiferus* and *Penaeus aztecus*) from Calcasieu River/Lake Complex, LA contained heptachlor at concentrations ranging from undetected levels to 0.75 ug/g [60]. In 1984, heptachlor and heptachlor epoxide combined were detected in Cyprinid Fish (*Barbus xanthopterus*) from the Shatt al-Arab River, Iraq at concentrations ranging from undetected levels to 13 ppb [24]. In March to June, 1986, heptachlor was detected in black bullhead from the Garigliano River in Southern Italy at an average concentration of 10 ng/g with a frequency of occurrence of 21% [4]. Heptachlor was detected in black bullhead, chub, common carp and eel from the Voltorno River in Southern Italy at average concentrations of 20, 6, 5, and 5 ng/g with an overall frequency of occurrence of 70% [4]. Heptachlor was detected in chub, common carp, eel and tench from the Calore River in Southern Italy all at average concentrations of 5 ng/g with an overall frequency of occurrence of 78% [4]. Heptachlor was detected in black bullhead and bleak from the Sele River in Southern Italy both at an average concentrations of 5 ng/g with an overall frequency of occurrence of 35% [4]. Heptachlor was detected in common carp, channel catfish, smallmouth and largemouth bass, rock bass, pumpkinseed, bowfin, lake trout and northern pike from Lake Michigan collected at White Lake and the St Joseph, Kalamazoo, Grand, Muskegon, Pere Marquette, Manistee, Platte, Boardman, Grand Traverse, Manistique, Whitefish, Escanaba and Ford Rivers at concentrations ranging from 0.001 to 0.008 mg/kg wet weight [17]. Different fish species from Abu Qir Bay, Idku Lake, and Maryut Lake in Alexandria, Egypt, were assayed for residues of organochlorine insecticides and polychlorinated biphenyls (PCBs). The fish were obtained from commercial fishermen in 1985 and include the following species: *Pagellus erythrinus*, *Sargus vulgaris*, *Siganus rivulatus*, *Sphyræna sphyræna*, and *Trigla hirundo* from Abu Qir Bay; and Tilapia fish from Idku and Maryut Lakes. Twenty grams of dorsal fish muscle were extracted and the residues analyzed by GLC. Reagent blanks and spiked samples were included with each sample. The waters from which the fish were obtained receive drainage from industrial, agricultural and urban activities. Water samples were not assayed for specific components. Heptachlor was detected in all fish in the study. The highest levels of 5.3

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ug/kg were found in Pagellus erythrinus from Abu Qir Bay. Concentrations were highest in larger fish, but a linear increase with size was not apparent. Heptachlor is usually rapidly converted to heptachlor epoxide and other metabolites which may account for the low occurrence and low concentrations observed. From a health standpoint, all samples were well below permissible levels for heptachlor [28].

Animal Concentrations: Eggs and 5 day old chicks from the same clutch of herring gull (Larus argentatus), which nested on the island of Mellum located at 53.43 deg N and 06.54 deg E, contained heptachlor at average concentrations of 0.145 and 0.383 mg/kg [10]. Gull-billed terns collected in Italy during 1982 and 1983 contained heptachlor at concentrations ranging from 0.01 to 0.70 ug/g with a geometric mean of 0.05 ug/g [29]. Forster's tern eggs from Greenbay, WI contained heptachlor at concentrations ranging from 0.03 to 0.30 ug/g with a median concentration of 0.09 ug/g [43]. Forster's tern eggs from Lake Poygan, WI contained heptachlor at concentrations ranging from 0.01 to 0.03 ug/g with a median concentration of 0.02 ug/g [43]. Brain tissue of Goldeneye ducks that overwintered on the Niagara River contained heptachlor at concentrations ranging from 0.0023 to 0.0028 ug/g with a mean concentration of 0.0026 ug/g in December 1984 [34]. In February to March 1985, brain tissue of the Goldeneye ducks that overwintered on the Niagara River contained heptachlor at concentrations ranging from 0.0025 to 0.0032 ug/g with a mean concentration of 0.0028 ug/g [34].

Milk Concentrations: Heptachlor was detected with 0.2% frequency of occurrence and an average concentration of less than 0.1 ppb in 4,638 samples of cow's milk [25]. Heptachlor was detected in human milk of 4 of 4 mothers in Iraq at an average concentration of 0.051 mg/kg [2]. The average concentrations plus or minus the standard deviation of heptachlor and heptachlor epoxide combined within milk fat from the Northeast, Southeast, Midwest, Southwest and Northwest geographical regions of the United States in 1975 were reported to be 0.07 +/- 0.04 mg/kg, 0.13 +/- 0.21 mg/kg, 0.09 +/- 0.07 mg/kg, 0.07 +/- 0.10 mg/kg and 0.07 +/- 0.10 mg/kg, respectively [86]. The average concentration of heptachlor and heptachlor epoxide combined within whole milk in Kenya for 1979 was listed to be 0.5 ug/L [86]. For Alberta, Canada from 1966 to 1970 and from 1977 to 1978, the average concentrations of heptachlor and heptachlor epoxide combined within milk fat were listed to be 0.002

Heptachlor

mg/kg and 0.03 mg/kg, respectively [86]. The average concentration of heptachlor and heptachlor epoxide combined within milk fat in Mexico for 1976 was listed to be 0.01 mg/kg [86]. For France from 1971 to 1972 and Vienna, Austria from 1966 to 1970, the average concentrations of heptachlor and heptachlor epoxide combined within milk fat were reported to range from 0.06 to 1.30 mg/kg and 0.10 to 0.13 mg/kg, respectively [86]. For the Federal Republic of Germany from 1973 to 1974 and 1978, the average concentrations of heptachlor and heptachlor epoxide combined within milk fat were reported to range from 0.03 to 0.37 mg/kg and less than 0.01 to 0.11 mg/kg, respectively [86].

Other Environmental Concentrations: Heptachlor was detected in the house dust of 4 residences in Seattle, WA at concentrations ranging from 0.13 to 0.82 ppm [68]. Cossette from sugar beets in Chile, which are used as animal feed, contained heptachlor at concentration ranging from 0.004 to 0.022 ppm [62].

Probable Routes of Human Exposure: The most probable routes of human exposure are inhalation, dermal contact (skin absorption and/or eye contact) and ingestion. Infants are exposed to heptachlor from mothers and cow's milk [81].

Average Daily Intake: Typical human exposure to heptachlor has been calculated to be 0.01 ug/individual/day, based upon a mean ambient air concentration of 0.5 ng/m³ and a respiratory volume of 20 m³ of air per day [81].

Occupational Exposure: The most probable human exposure to heptachlor would be occupational exposure, which may occur through dermal contact or inhalation at places where it is produced or used. NIOSH (NOES Survey as of 3/28/89) has estimated that 933 workers are potentially exposed to heptachlor in the USA [61]. Potentially exposed populations consist of workers in manufacturing and formulating plants and field and home applicators of the pesticides [78]. Non-occupational exposures would most likely occur via inhalation of contaminated urban and indoor atmospheres, ingestion of contaminated foods and ground water supplies and dermal contact at recreational activities at contaminated waterways.

Body Burden: States was [70]. Heptachlor metabolite at concentration exposed to detected in concentration combined concentration but not quantified heptachlor at concentration with a free

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Heptachlor

Body Burdens: Human milk from 1436 women living in the United States was analyzed by GLC for chlorinated hydrocarbon insecticides [70]. Heptachlor was found in less than 2%, but heptachlor epoxide, its metabolite, was found in 63% of the samples [70]. Heptachlor was found at concentrations less than 1 to 2 ng/g in the milk of Australian women exposed to heptachlor from its use as an insecticide [74]. Heptachlor was detected in human milk of 4 of 4 mothers in Iraq at an average concentration of 0.051 mg/kg [2]. Heptachlor and heptachlor epoxide combined were found in 2 of 4 human placentas of mothers in Iraq at concentrations of 0.015 and 0.028 mg/kg [2]. Heptachlor was detected but not quantified in human adipose tissue [5]. During 1982 and 1983, heptachlor was detected in the blood of 112 residents of El Paso, Texas at concentrations up to 9.9 ppb with a mean concentration of 3.1 ppb and with a frequency of occurrence of 19% [59].

REFERENCES

1. Adams RS Jr; *J Minn Acad Sci* 34: 44-8 (1967)
2. Al-Omar MA et al; *Environ Pollut Series A* 42: 79-91 (1986)
3. Albert LA et al; Comparative Studies of the Chlorinated Hydrocarbons Residues in Hen's Eggs in Mexico. and A Survey of Chlorinated Hydrocarbons Residues in Cheese from Three Mexican Regions. in *Am Chem Soc Div Environ Chem Preprint June 5-11 Meet* pp 471-82 (1988)
4. Amodio-Cocchieri R, Arnesi A; *Bull Environ Contam Toxicol* 40: 233-9 (1988)
5. Anderson HA; *Environ Health Perspect* 60: 127-31 (1985)
6. Anderson DJ, Hites RA; *Atmos Environ* 23: 2063-6 (1989)
7. Atkinson R, Carter WPL; *Chem Rev* 84: 437-70 (1984)
8. Atkinson R; *Intern J Chem Kin* 19: 799-828 (1987)
9. Bagnati R et al; *Chemosphere* 17: 59-65 (1988)
10. Becker PH, Sperveslage; *Bull Environ Contam Toxicol* 42: 721-7 (1989)
11. Biddinger GR, Gloss SP; *Res Rev* 91: 103-45 (1984)
12. Bidleman TF et al; *Atmos Environ* 21: 641-54 (1987)
13. Biggar JW, Riggs RI; *Hilgardia* 42: 383-91 (1974)
14. Bourquin AW et al; *Devel Indus Microbiol* 13: 264-76 (1972)
15. Brodtmann NV Jr; *Bull Environ Contam Toxicol* 15: 33-9 (1976)
16. Callahan MA et al; *Water-Related Environ Fate of 129 Priority Pollut USEPA-440/4-79-029a* (1979)
17. Camanzo J et al; *J Great Lakes Res* 13(3): 296-309 (1987)
18. Carter FL, Stringer CA; *Pestic Cont* 39: 13-22 (1971)
19. Castro TF, Yoshida T; *J Agric Food Chem* 19: 1168-80 (1971)
20. Chapman RA, Cole CM; *J Environ Sci Health B17*: 487-504 (1982)
21. Cohen DB; in *ACS Symp Ser* 315: 499-529 (1986)
22. DeVault DS; *Arch Environ Contam Toxicol* 14: 587-94 (1985)

Heptachlor

23. DouAbul AAZ et al; Arch Environ Contam Toxicol 17: 405-18 (1988)
24. DouAbul AAZ et al; Bull Environ Contam Toxicol 38: 674-80 (1987)
25. Duggan RE et al; Pestic Res Levels in Foods in U.S. from July 1, 1969 to June 30, 1976 FDA and AOAC (1983)
26. Eichelberger JW, Lichtenberg JJ; Environ Sci Technol 5: 541-4 (1971)
27. Eisenreich SJ et al; Environ Sci Technol 15: 30-8 (1981)
28. El Nabawi A et al; Arch Environ Contam Toxicol 16 (6): 689-96 (1987)
29. Fasola M et al; Environ Pollut 48: 25-36 (1987)
30. Fox ME et al; Marine Pollut Bull 19: 333-6 (1988)
31. Glotfelty DE et al; J Agric Food Chem 32: 638-43 (1984)
32. Gore RC et al; J Assoc Anal Chem 54: 1040-82 (1971)
33. Great Lakes Water Quality Board; Inventory Chem Subst Id Great Lakes Ecos p 195 (1983)
34. Great Lakes Water Quality Board; 1987 Report on Great Lakes Water Quality, Appendix B. Great Lakes Surveillance Volume II (1989)
35. Greenberg M et al; Environ Sci Technol 16: 14-9 (1982)
36. Harris CI; J Agric Food Chem 17: 80-2 (1969)
37. Harris CR, Sans WW; Pestic Monit J 5: 259-67 (1971)
38. Hawley GG; Condensed Chemical Dictionary 10th ed Van Nostrand Reinhold NY p 522 (1981)
39. Hill DW, McCarty PL; J Water Pollut Cont Fed 39: 1259-77 (1967)
40. Kahunyo JM et al; Poultry Sci 65: 1084-9 (1986)
41. Kenaga EE; Ecotox Env Safety 4: 26-30 (1980)
42. Kessabi M et al; Sci Total Environ 71: 209-14 (1988)
43. Kubiak TJ et al; Arch Environ Contam Toxicol 18: 706-27 (1989)
44. Kuntz KW; Toxic Contam in the Niagara River 1975-82, Environ Canada, Inland Waters Directorate, Water Quality Branch, Tech Bull No.134 (1984)
45. Lal R et al; Bull Environ Contamin Toxicol 42: 45-9 (1989)
46. Leigh GM; J Water Pollut Cont Fed 41: R450-60 (1969)
47. Lewis RG et al; Environ Monit Assess 10: 59-73 (1988)
48. Lewis RG, Lee RE-eds; Air Pollution from Pesticide and Agricultural Processes. CRC Press Cleveland, Ohio pp 5-51 (1976)
49. Louis JB, Kisselbach KC Jr; Bull Environ Contam Toxicol 39: 911-18 (1987)
50. Luke MA et al; J Assoc Off Anal Chem 71: 415-20 (1988)
51. Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Environmental Behavior of Organic Compounds. McGraw-Hill NY pp 15-11, 15-21 (1982)
52. MacMonegle CW Jr et al; J Environ Sci Health B 19: 39-48 (1984)
53. Mansour M, Parlar H; J Agric Food Chem 26: 483-5 (1978)
54. McDougall KW et al; Bull Environ Contam Toxicol 39: 286-93 (1987)
55. McFall JA et al; Chemosphere 14: 1253-65 (1985)
56. Menzie CM; Metabolism of Pesticide, An Update Special Scientific Report Wildlife No.184 (1974)
57. Miles JRW et al; J Econ Entomol 64: 839-41 (1971)
58. Miles JRW et al; J Econ Entomol 62: 1334-8 (1969)
59. Mossing ML et al; J Environ Health 47: 312-3 (1985)

60. Murr:
61. NIOS
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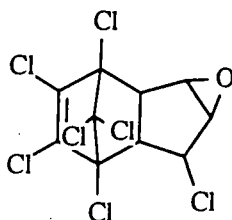
60. Murray HE, Beck JN; Bull Environ Contam Toxicol 44: 798-804 (1990)
61. NIOSH; National Occupational Exposure Survey (NOES) (1989)
62. Ober AG et al; Bull Environ Contam Toxicol 38: 404-8 (1987)
63. Ober A et al; Bull Environ Contam Toxicol 38: 528-33 (1987)
64. Page GW; Environ Sci Technol 15: 1475-81 (1981)
65. Parlar H et al; J Agric Food Chem 26: 1321-1324 (1978)
66. Podowski AA et al; Arch Environ Contam Toxicol 8: 509-18 (1979)
67. Rico MC et al; Water Res 23: 57-60 (1989)
68. Roberts JM, Camann DE; Bull Environ Contam Toxicol 43: 717-724 (1989)
69. Sanborn JR et al; The Degradation of Selected Pestic in Soil: A Rev of Published Literature. USEPA-600/9-77-02 (1977)
70. Savage EP et al; Am J Epidemiol 113 (4): (1981)
71. Schimmel SC et al; J Toxicol Environ Health 2: 169 (1976)
72. Schueuermann G, Klein W; Chemosphere 17(8): 1551-74 (1988)
73. Spalding RF et al; Pestic Monit J 14: 70-3 (1980)
74. Stacey CI, Tatum T; Bull Environ Contam Toxicol 35: 202-8 (1985)
75. Stanley CW et al; Environ Sci Technol 5: 430-5 (1971)
76. Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)
77. Suntio LR et al; Critical review of Henry's Law Constants for Pesticides, Reviews of Environ Contam Toxicol 103: 1-59 (1988)
78. USEPA/CAG; Carcinogenicity Risk Assessment for Chlordane and Heptachlor/Heptachlor Epoxide (Draft) p.3-7 EPA Contract No. 68-02-4131 (1985)
79. USEPA/ODW; Health Advisory: Heptachlor/Heptachlor Epoxide (Draft) p 3 (1985)
80. USEPA; Treatability Manual Vol.1 Treatability data USEPA-600/2-81-001a (1981)
81. USEPA; Ambient Water Quality Criteria Doc: Heptachlor p C-43 EPA 440/5-80-052 (1980)
82. USEPA; Treatability Manual Vol 1 Treatability data USEPA-600/2-81-001a (1981)
83. Veith GD et al; J Fish Res Board Can 36: 1040 (1979)
84. Verkataramani ES et al; CRC Crit Rev Environ Control 14: 333-76 (1984)
85. Warner HP et al; Determination of Henry's Law Constants of Selected Priority Pollutants EPA/600/D-87/229; NTIS PB87-212684 (1987)
86. WHO; Environ Health Criteria: Heptachlor p 25-29 (1984)
87. Wiersma GB et al; Pestic Monit J 6: 126-9 (1972)
88. Williams WM et al; Pesticides in Ground Water Database: 1988 Interim Report NTIS PB89 164230 AS (1988)
89. Zaroogian GE et al; Environ Toxicol Contam 4: 3-12 (1985)

Heptachlor Epoxide

SUBSTANCE IDENTIFICATION

Synonyms: 1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindan

Structure:



CAS Registry Number: 1024-57-3

Molecular Formula: $C_{10}H_5Cl_7O$

Wiswesser Line Notation: T D3 C555 A EQ JUTJ AG AG BG GG IG JG KG

CHEMICAL AND PHYSICAL PROPERTIES

Boiling Point:

Melting Point: 160-161.5 °C

Molecular Weight: 389.40

Dissociation Constants:

Log Octanol/Water Partition Coefficient: 5.40 (calculated) [141]

Water Solubility: 0.200 mg/L [10]

Vapor Pressure: 1.95×10^{-5} mm Hg (estimate) [107]

Henry's Law Constant: 3.2×10^{-5} atm-m³/mole [142]

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Heptachlor Epoxide

ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

Summary: Heptachlor epoxide is not produced commercially, but rather is formed by the chemical and biological transformation of heptachlor in the environment. In 1978, the USEPA cancelled the registration of heptachlor and chlordane, which contains 10% heptachlor and agricultural uses of these insecticides were phased out. After July 1, 1983 heptachlor and chlordane could only be used for underground termite control. Heptachlor epoxide adsorbs strongly to soil and is extremely resistant to biodegradation, persisting for many years in the upper soil layers. Some volatilization or photolysis loss may occur. If released into water, it will adsorb strongly to suspended and bottom sediment. Little biodegradation would be expected. Heptachlor epoxide is expected to exist in both the vapor and particulate phases in ambient air. Vapor phase reactions with photochemically produced hydroxyl radicals may be an important fate process (an estimated half-life of 1.5 days). Heptachlor epoxide that is associated with particulate matter and aerosols should be subject to gravitational settling and washout by rain. Due to its stability, long range dispersal occurs, resulting in the contamination of remote areas. Some photolysis loss probably occurs but there is no data to evaluate the rate of this process. Heptachlor is bioconcentrated extensively. It is taken up into the food chain by plants and bioconcentrates into fish, animals and milk. Residues in human milk primarily comes from eating meat and fish as is evident by the much lower concentration in the milk of vegetarians. However, uptake in humans via inhalation of vapors in houses treated with heptachlor and chlordane is also evident. Where monitoring at the top of the food chain was performed such as residues in bald eagles and the ongoing Illinois Milk Survey, levels of heptachlor epoxide have not significantly changed three years after agricultural uses of the pesticide were being phased out. Exposure to heptachlor epoxide is primarily through the ingestion of food containing residues of the insecticide. The food classes most in risk are dairy products and meat/poultry/fish.

Natural Sources: Heptachlor epoxide is not known to occur as a natural product [75].

Artificial Sources: Heptachlor epoxide is not produced commercially in the US nor is it normally present as an impurity in commercial heptachlor [75]. It is formed by the chemical and biological

Heptachlor Epoxide

transformation of heptachlor in the environment [75]. These include photolytic action on plant surfaces, bacterial action, and microsomal oxidation in organisms [91]. Heptachlor, a non-systemic stomach and contact insecticide was introduced commercially in 1952 and was used for control of soil insects, seed treatment, and termite control [147]. Heptachlor's use may be gauged from the statistics that an estimated 930 kg were used in the US in 1974 as follows: on corn, 58%; by pest control operators, 26.8%; as a seed treatment, 13.2%; miscellaneous, 2% [75]. On March 6, 1978, the US EPA cancelled the registration of heptachlor and chlordane, which contains 10% heptachlor [91]; the settlement calling for phasing out agricultural uses of the pesticide [75]. After July 1, 1983 heptachlor and chlordane may only be used for underground termite control [75]. After application of heptachlor to soil, the epoxide is measurable in air after 6 days and in soil after 21 days [109].

Terrestrial Fate: Heptachlor epoxide adsorbs strongly to soil and is extremely resistant to biodegradation. Monitoring studies reveal that it persists for many years in soil and does not appear to leach significantly into the lower soil layers. On the soil surface, heptachlor epoxide may slowly photodegrade, particularly during the summer months (1% per month). Heptachlor epoxide loss from soil in a microagricultural chamber is observed after application, but the rate of loss decreases over the course of a few days. This loss may be due to volatilization or photolysis of the chemical from the surface microlayer.

Aquatic Fate: If released into water, heptachlor epoxide will adsorb strongly to suspended and bottom sediment. Little biodegradation would be expected and photolysis probably would only be significant in surface waters in the presence of photosensitizers. While slow volatilization of the free molecule (half-life 60 hr from a model river) would be expected, since heptachlor epoxide would be mainly adsorbed to particulate matter, this would not be a primary loss mechanism. No measurable degradation occurred when 10 ppb of heptachlor epoxide was incubated in water of the Little Miami River, a stream receiving domestic, industrial, and agricultural wastes for 8 weeks in sealed jars under sunlight and artificial lights [36]. Heptachlor epoxide was very persistent in a model ecosystem, having approximately the same environmental stability as dieldrin [91].

Its estimated differences

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Biodegradation incubated for test mixture heptachlor $^\circ\text{C}$, a mean occurred after degradation with any of heptachlor m^3 when incubated incubated and significant d

Abiotic Degradation was irradiated other hand, $>280 \text{ nm}$ [7 hours on irradiated photolysis o

Heptachlor Epoxide

Its estimated half-life in the lower Rhine River based on concentration differences between sampling points was 35 days [149].

Atmospheric Fate: Based upon the vapor pressure, heptachlor epoxide is expected to exist in both the vapor and particulate phases in ambient air [37]. In the atmosphere, vapor phase reactions with photochemically produced hydroxyl radicals may be an important fate process. The rate constant for the vapor-phase reaction of heptachlor with photochemically produced hydroxyl radicals has been estimated to be 1.09×10^{-11} cm³/molecule-sec at 25 °C, which corresponds to an atmospheric half-life of about 1.5 days at an atmospheric concentration of 5×10^5 hydroxyl radicals per cm³ [5]. Heptachlor epoxide that is associated with particulate matter and aerosols in the atmosphere should be subject to gravitational settling and washout by rain. Contamination of lakes with heptachlor epoxide is believed to occur primarily by wet deposition. Under the proper conditions, heptachlor epoxide bearing dust can be transported for thousands of miles. Photolysis would be expected to occur but there are no data on the extent of heptachlor epoxide degradation in dispersed dust and aerosols.

Biodegradation: No degradation occurred when heptachlor epoxide was incubated for a week with a wastewater inoculum and a portion of the test mixture used as seed for 3 sequential week-long tests [136]. When heptachlor epoxide was incubated with a sandy loam soil inoculum at 28 °C, a mean conversion of 2.8, 5.8, and 12.0% to 1-exohydroxychlordeane occurred after 4, 8, and 12 wk, respectively [105]. No significant degradation occurred when heptachlor epoxide was incubated at 45 °C with any of 7 air-dried soils for 8 days [11]. Under anaerobic conditions, heptachlor epoxide degraded slowly (half-life approximately 25 days) when incubated with thick digester sludge at 35 °C [72]. However, when incubated anaerobically with dilute sludge at 20 °C or aerobic sludge, no significant degradation was noted in 60 days [72].

Abiotic Degradation: When a solution of heptachlor epoxide in acetone was irradiated with light >300 nm, 99% disappeared in 11 hr [7]. On the other hand, 99% disappearance occurred in 1 hr on irradiation with light >280 nm [7]. Another investigator obtained a 3-5% degradation in 2 hours on irradiation with intense UV light >290 nm [98]. No data on the photolysis of heptachlor epoxide in aqueous solution could be found in

Heptachlor Epoxide

the literature. When a thin film of heptachlor epoxide was placed in sunlight, 45% loss occurred after 250 hr [7]. Heptachlor epoxide is also converted to photoproducts when exposed to sunlight on the surface of plants; 50-60% conversion occurring in 4 hr on rotenone-treated bean leaves to a product that is identical to that formed on UV irradiation of an acetone solution. The rotenone acted as a photosensitizer, as does acetone, and no detectable photoproducts were formed in the absence of rotenone [76]. The photolysis product was a ketone [7,76]. The form of solid material and the intensity of illumination affects the rate of photolysis. For example, when exposed to July sunshine, 59.3% of powdered heptachlor epoxide decomposed in 557 hr while complete decomposition occurred in 121 hr when dispersed in a solid transparent medium [58]. When a powdered sample of heptachlor epoxide was irradiated on a rooftop from January through mid September, degradation was almost negligible until May, then increased through July, reaching a maximum decomposition rate of 1%/day at the end of July. By the end of the experiment (8 1/2 mo), 39% of the original material had disappeared [58]. Hydrolysis is not environmentally significant [94]. The rate constant for the vapor-phase reaction of heptachlor epoxide with photochemically produced hydroxyl radicals has been estimated to be $1.09 \times 10^{-11} \text{ cm}^3/\text{molecule-sec}$ at 25 °C, which corresponds to an atmospheric half-life of about 1.5 days at an atmospheric concentration of 5×10^{-5} hydroxyl radicals per cm^3 [5].

Bioconcentration: The bioconcentration of heptachlor epoxide in freshwater clam (*Corbicula manilensis*) fat was 2330 as determined in a 72-day experiment [67]. In fathead minnows the BCF was 14,400 as determined in a 32-day test in a flow-through aquarium [141]. The steady state BCF for sheepshead minnow (*Cyprinodon variegatus*), pinfish (*Lagodon rhomboides*), mussels (*Mytilus edulis*), and oyster (*Crassostrea virginica*) is 4500, 2900, 1700, and 851, respectively [148]. In a 33-day model ecosystem, the BCF was 4900 in fish (*Gambusia*), 66,000 in snail (*Physa*), and 1600 in alga (*Oedogonium*) [91]. Based on the log octanol/water partition coefficient, one would estimate a BCF of 7500 in fish using a recommended regression equation [93].

Soil Adsorption/Mobility: The partition constant of heptachlor epoxide to bentonite clay is 100 [72]. Based on the water solubility, one would estimate a Koc of 7800 using a recommended regression equation [93].

From the relative suspended solid coefficient between

Volatilization for heptachlor epoxide from a 1 m deep water body. About 11% of the volatilized at 2.5 m/hr. The loss rate leveled off after 20 hr from the start. When heptachlor epoxide pesticides was applied to soil in a microcosm [107]. The dissipation rate was 0.063 kg/ha/day.

Water Concentration: Heptachlor epoxide was not detected in water samples collected between 1965 and 1975. Diet samples [5]. Heptachlor epoxide was not detected in municipal and private wells in the San Joaquin Valley. It was, however, detected in less than 44 ppb in private wells [139]. GROUNDWATER: Heptachlor epoxide was not quantified, in N. agricultural land. Heptachlor epoxide was not detected in water samples from an area known to be contaminated by the presence of heptachlor and its metabolites. Heptachlor epoxide was not detected in a groundwater sample at 100 ug/L [132]. Heptachlor epoxide was not detected in golf courses. Heptachlor epoxide concentrations were not detected in 0.16 ug/L with a

Heptachlor Epoxide

From the relative concentration of heptachlor epoxide in water and suspended solids in the Grand and Saugeen Rivers, the partition coefficient between these phases is 10,000 to 20,000 [46].

Volatilization from Water/Soil: Based upon the Henry's Law constant for heptachlor epoxide, the volatilization half-life from a model river 1 m deep with a 1 m/sec current and a wind of 3 m/sec is 60 hr [93]. About 11% of the heptachlor epoxide added to a seawater aquarium aerated at 2.5 l/hr was lost over the course of 17 hr [41]. However the loss rate leveled off after that time [41]. Heptachlor epoxide has a 42% loss in 20 hr from a jar containing mosquito larvae held at 26.5 °C [74]. When heptachlor epoxide in conjunction with several other chlorinated pesticides was applied to the surface of warm, moist, fallow, sandy loam soil in a microagroecosystem chamber, 42.5% volatilized after 11 days [107]. The dissipation rate was initially 0.14 kg/ha/day and decreased to 0.063 kg/ha/day by the 9th day [108].

Water Concentrations: DRINKING WATER: Heptachlor epoxide was not detected in samples of drinking water from 10 to 13 US cities collected between Oct 1975 and Mar 1982 for Infant and Toddler Total Diet samples [50,51,53,54,78,79]. Similarly, it was not found in 54 municipal and private wells sampled in agricultural areas of California in the San Joaquin Valley and Santa Barbara and Monterey counties [96]. It was, however, reported in tap water in Ottawa, Canada at a level of less than 44 ppt [83]. Heptachlor and heptachlor epoxide have been detected in private drinking wells at concentrations less than 0.02 ug/L [139]. **GROUND WATER:** Heptachlor epoxide was detected, but not quantified, in New Jersey ground water in areas generally devoted to agricultural land uses [62]. During the 1978 irrigation season, 14 ground water samples were collected in the central plateau region of Nebraska, an area known to have high nitrate-nitrogen levels, and were analyzed for the presence of 13 residues. Levels of the organochlorine insecticide, heptachlor and its derivative, heptachlor epoxide, were all below the detectable limits of 0.005 to 0.010 ug/L [125]. Heptachlor epoxide was detected in a ground water well in Kansas at a concentration of 0.026 ug/L [132]. Heptachlor epoxide was detected in ground water underneath golf courses in Bass River and Hyannisport, Massachusetts at concentrations ranging from 0.03 to 0.06 ug/L and undetected levels to 0.16 ug/L with average concentrations of 0.04 and 0.07 ug/L, respectively

Heptachlor Epoxide

[25]. SURFACE WATER: Of the 4632 stations reporting heptachlor epoxide in ambient water in EPA's STORET database, 36.0% contained detectable levels of the chemical with a median concentration of 0.001 ppb [61]. According to the 1975 to 1980 National Summary of the Pesticide Monitoring Network sponsored by the EPA and US Geological Survey, heptachlor epoxide was detected at 4.5% of 177 stations across the nation with a frequency of occurrence of 0.3% for 2,946 samples [56]. In 1979, heptachlor epoxide was detected at 5.3% of 171 stations across the nation with a frequency of occurrence of 1.0% for 1,017 samples [56]. Heptachlor epoxide was listed as a contaminant of the Great Lakes including Lakes Ontario, Erie, Huron, Michigan, Superior and St Clair [59]. In an inventory of chemical substances identified in the Great Lakes ecosystem, heptachlor epoxide was detected in Lake Ontario, 7 of 9 samples; Lake Erie, 11 of 22 samples; St. Clair River, 2 of 2 samples; Lake Huron, 7 of 10 samples; Lake Michigan, 10 of 15 samples and Lake Superior, 4 of 6 samples [59]. The positive results included the lake water of all the Great Lakes in addition to rivers and creeks feeding into the lakes [59]. Heptachlor epoxide was detected at 14 of 14 sampling stations throughout Lake Ontario at concentrations ranging from 0.167 to 0.375 ng/L [8]. On August 7, 1985, heptachlor epoxide was detected at 13 of 13 sampling stations throughout Lake St Clair at concentrations ranging from 0.087 to 0.203 ng/L [22]. The mean concentration of heptachlor epoxide in waters collected from 11 agricultural watersheds in Ontario, in 1975-76 and 1976-77 were 1.1 and 0.5 ppt, respectively, with the overall presence being 3.8 and 8.1% [45]. For 1976-77, the Grand and Saugeen Rivers in this study had mean concentrations in river water of 0.03 and 0.05 pt and 0.3 and 1 ppb in suspended solids [46]. Forty-seven percent of samples from the lower Niagara River in 1980-81 contained heptachlor epoxide at an average concentration of 0.5 ppt [85]. In another study, 13.9-22.6 ppt of the chemical was found in the surface microlayer at 5 stations in the Niagara River but none was found in subsurface water or suspended solids [97]. Heptachlor epoxide was detected in Thompson's tributary to the Niagara River at a concentration of 0.05 ng/L [60]. In 1982, heptachlor epoxide was detected in 3% of the surface water samples from Hamilton Harbor, Lake Ontario at concentrations ranging from undetected levels to 1 ng/L [114]. About 2 to 3.9 ppt was found in Lake Pontchartrain, LA, a shallow estuary in the Mississippi delta [101]. Despite the presence of cyclodienes in its effluent and the continued use of heptachlor and heptachlor epoxide, heptachlor

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Heptachlor Epoxide

epoxide was not detected in the water column near the ocean outfall of the Los Angeles County Sanitation District at White Point, CA [61]. Heptachlor epoxide was detected in waters off the coast of Argentina at concentrations ranging from undetected levels to 3.7 ng/L with a mean of 1.9 ng/L [27]. RAIN/SNOW: According to the Canadian Network for Sampling Organic Samples in Precipitation, heptachlor epoxide was detected in 0 to 33% with a median of 6% of the 210 samples of precipitation from the 12 sampling sites throughout Canada [12]. A sample from Windsor, Ontario contained the highest levels of 46 ppt [12]. The concentration of heptachlor epoxide in rain at two sites at opposite ends of Lake Superior ranged from ND to 1.3 ppt, which contributed to the estimate that 17.0 kg of the chemical enters the lake from rain and snow each year [134]. Canadian arctic snow contained heptachlor epoxide at concentrations ranging from undetected levels to 0.41 ng/L [63].

Effluent Concentrations: Of the 672 stations reporting heptachlor epoxide in industrial effluents in EPA's STORET database, 4.2% contained detectable levels of the chemical with a median concentration of less than 0.007 ug/L [129]. In a comprehensive survey of wastewater from 4000 industrial and publicly owned treatment works (POTWs) sponsored by the Effluent Guidelines Division of the U.S. EPA, heptachlor epoxide was only identified in discharges of publicly owned treatment works with a 1% frequency of occurrence and a median concentration of 19.3 ppb [123]. In the National Urban Runoff Program in which samples of runoff were collected from 19 cities at 51 catchments in the U.S., heptachlor epoxide was detected only in Washington, DC, which accounted for 1% of the samples, at a level of 0.1 ppb [26].

Sediment/Soil Concentrations: SOIL: In a study of 31 Ontario apple orchards conducted from 1972 to 1975, residues of heptachlor epoxide ranged from undetectable levels to 97 ppb with a frequency of occurrence of 14% and a detection limit 0.4 ppb in the upper 15 cm of soil, but it was absent from the 15 to 30 cm layer [47]. As part of the National Soils Monitoring Program, 1486 samples of cropland soil in 37 states were analyzed for pesticide residues in 1971 [21]. There were 6.9% positive detections for heptachlor epoxide with levels ranging from 0.01 to 0.43 ppm [21]. States with the highest incidence were Illinois, Iowa, Nebraska,

Heptachlor Epoxide

Missouri, and Indiana [21]. In a 1970 study of residues in Corn Belt States that sampled 400 sites in 12 states, 7 states had sites with detectable levels of heptachlor epoxide with occurrences ranging from 2.7 to 23.2% and a mean concentration of 0.01 ppm or less, and a maximum residue of 0.31 ppm [19]. Illinois had the highest number of positive samples [19]. Twenty-five soil samples out of 380 from 5 metropolitan areas contained heptachlor epoxide residues at average concentrations of less than 0.01 to 0.02 ppm with a maximum concentration of 1.95 [20]. A survey of pesticide residues in soil on 6 US Air Force bases in 1975 and 1976 resulted in residues of heptachlor epoxide ranging from less than 10 ppb (detection limit) to 60 ppb [88]. The percentage of positive sites for the two years were (land type, percent): residential, 15.0% (1975), 35.0% (1976); open land, 17.0% (1975), 14.3% (1976); golf courses, 11.8% (1975), 17.7% (1976) [88]. The percentage of positive sites containing heptachlor, its precursor, declined between 1975 and 1976 [88]. Heptachlor epoxide was detected in tobacco fields at levels of 30 and 10 ppb at depths of 0-15 cm and 15-23 cm, respectively, 3 mo after application with heptachlor, although no heptachlor epoxide was detected immediately after application [75]. Agricultural soils on the North Coast Region of New South Wales, Australia were shown to contain heptachlor epoxide at concentrations ranging from undetected levels to 0.14 ppm [100].

SEDIMENT: Of the 1710 stations reporting heptachlor epoxide in sediment in EPA's STORET database, 25.0% contained detectable levels of the chemical with a median concentration of 0.1 ppb by dry wt [129]. About 37% of suspended sediment samples from the lower Niagara River in 1980 to 1981 contained heptachlor epoxide at a mean concentration of 1 ppb dry weight [85]. The mean concentrations of heptachlor epoxide in river bed sediment at the mouth of the Grand and Saugeen Rivers in Ontario during 1975 to 1976 were 1 ppb and not detected, respectively [46]. Heptachlor epoxide was detected in 2 of 42 sediment samples from Wolfe Island, St. Lawrence River collected between 1982 and 1984 [59]. Heptachlor epoxide concentrations in all sediment samples collected from the St. Lawrence River were less than 1 ug/kg [59]. Lacustrine sediment samples deposited over time in Lake Ontario contained heptachlor epoxide at concentration as high as 50 ng/g [38]. Sediment samples extracted at increasing depths showed a steady increase in the concentration of heptachlor epoxide from 1930 to 1970 and a steady decline in concentration from 1970 to 1980 [38]. No heptachlor epoxide was detected in bottom sediment at 13

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Heptachlor Epoxide

locations in the Potomac River Basin in 1972 or 1976 [42]. Heptachlor epoxide was detected in sediments from Manukau Harbor, New Zealand at concentrations of less than 0.1, 0.1 and 0.3 ng/g for sampling points located at Waiuku Inlet, Mangere Inlet and Big Muddy Creek, respectively [44]. Heptachlor epoxide was detected in sediments from the coast of Argentina at concentrations ranging from 0.1 to 18.7 ng/g with a mean of 0.6 ng/g [27].

Atmospheric Concentrations: URBAN: The mean and maximum air concentration of heptachlor epoxide near Delft, the Netherlands as determined from fifty-five 24 hour samples taken over the period from June 1979 to March 1981 was 32 and 360 pg/m³ [65]. The average concentration of chlorinated pesticides was 3 times higher in summer than in winter [65]. Air samples from Miami, FL and Fort Collins, CO did not contain detectable quantities of the chemical [86]. All air samples from Miami as well as those from Jackson contained the precursor insecticide, heptachlor [86]. Heptachlor epoxide was not detected in any of the 880 composite samples from 9 locations in the US, whereas heptachlor was found at 2 locations [127]. A sample of dust collected in Cincinnati that originated on the Southern High Plains during a mammoth dust storm contained 40 ppb of heptachlor epoxide [24]. Heptachlor epoxide was also detected in the air of Stockholm, Sweden between October 13 to 15, 1983 [9]. SUBURBAN: A pilot air monitoring program at 3 suburban locations found that 20% of samples from Jackson, MI contained mean and maximum heptachlor epoxide concentrations of 0.2 and 1.3 ng/m³, respectively [86].

Food Survey Values: Heptachlor epoxide residues were found in commercially prepared baby foods that were sampled from July 1963 to June 1967 with a frequency of detection of 0.9% for 684 samples [140]. Most of the positive samples showed heptachlor epoxide residues in the range from trace quantities to 0.03 mg/kg [140]. Heptachlor epoxide was detected in chicken fat samples collected between April 1980 and February 1982 in Kenya [80]. A basket study of food from Ontario, Canada was performed on Aug 14, 1985 and heptachlor epoxide was detected in milk and eggs/meat at average concentrations of 0.00021 and 0.00012 ug/g, respectively [28]. Heptachlor and heptachlor epoxide combined were detected at an average concentration of 0.1 ppb with a frequency of detection of 0.4% among 784 samples of domestic cheese

Heptachlor Epoxide

[35]. Heptachlor and heptachlor epoxide combined were detected at average concentrations of less than 0.1 ppb and 0.6 ppb with frequencies of detection of 0.4% and 0.2% among 2,954 and 4,117 samples of domestic and imported vine and ear vegetables, respectively [35]. For 947 samples of domestic whole grains, the average heptachlor and heptachlor epoxide combined concentration was less than 0.1 ppb with a frequency of occurrence of 0.2% [35]. Heptachlor and heptachlor epoxide combined were detected at average concentrations of 126 ppb and 40 ppb with ranges from 40 to 50 ppb and trace quantities to 19,000 ppb, and with a frequencies of detection of 3.6% and 1.9% among 280 and 104 samples of soybeans, and corn and corn products, respectively [35]. Heptachlor and heptachlor epoxide were infrequently found in leaf and stem vegetables [35]. For 15,200 and 11,340 samples of red meat and poultry, heptachlor and heptachlor epoxide combined were detected at average concentrations of 16 and 13 ppb with frequencies of occurrence of 20.7% and 16.5%, respectively [35]. During a 5 year period from 1982 to 1986, the FDA Los Angeles District Laboratory analyzed 19,851 samples of domestic and imported food and feed commodities for pesticide residues [92]. Heptachlor epoxide was detected 11 times at concentrations less than 0.05 ppm and once at a concentration between 0.10 and 0.50 ppm [92]. Results for heptachlor epoxide from the US FDA's Total Diet studies of pesticides and other chemicals in Infant and Toddler Total Diet samples in which typical 14-day diet samples are collected from urban areas throughout the US (Fiscal Year - average intake (ug/kg body weight/day) are: Infants FY77 0.013, FY78 0.023, FY79 0.021, FY80 0.019, FY81/82 0.010; Toddlers FY77 0.018, FY78 0.019, FY79 0.018, FY80 0.020, FY81/82 0.009 [50,51]. For FY81/82 this represented an average daily intake of 0.0860 and 0.121 ug for infants and toddlers, respectively [50]. The food classes contributing to this input were (class - average concentration in ppb): whole milk 1; other dairy products and substitutes 2-7; meat/fish/poultry 1; potatoes <1; oils and fats 4 [50]. Results from the US FDA's Adult Total Diet Study in which the typical 14-day diet of a 16-19 yr male was collected from market basket composite samples in 12 food groups throughout the US (Fiscal Year - average intake (ug/kg body wt/day)) are: FY71-76 0.006 mean [35]; FY77 0.007 [52]; FY78 0.008; FY79 0.006; FY80 0.007; FY81/82 0.007 [53]. For FY81/82, market basket samples from 27 cities throughout the U.S. were collected and analyzed from each of 12 food groups [53]. There were 44 positive samples containing trace to 4 ppb of

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Heptachlor Epoxide

heptachlor epoxide, 35 of which were in dairy products and meat/fish/poultry, and averaged 0.3 and 0.7 ppb, respectively [53]. The average 70 kg man would have an intake of 0.467 ug/day [53]. In a Canadian total diet study which took winter and summer composite samples of 11 food classes in 5 Canadian cities, heptachlor epoxide was identified in 9 of 10 composites of dairy products with an input range of 0.1 to 0.2 ug/person/day, and 1 of 11 samples of oils and fats with an input 0.01 ug/person/day [102]. Mean residues of heptachlor and heptachlor epoxide combined in soybeans in Illinois rose slightly from 5.3 to 6.6 ppb from 1974 to 1980 despite the fact that heptachlor use on soybean fields dropped dramatically after 1974 and was eliminated after 1977 [95]. There was, however, a slight decline in the percentage of fields having residues greater than 10 ppb [95]. All of the beef and 75% of the lamb sampled in Baghdad contained heptachlor/heptachlor epoxide at average concentrations of 67 and 124 ppb, respectively [1].

Plant Concentrations: As part of the Pesticide Residue Monitoring Program, residue levels in mature crops were collected from 729 sites in 1971 [21]. Corn stalk was the only crop in which more than 1 or 2 samples were positive having a 7.7% incidence in 286 samples with residue levels ranging 0.01 to 0.51 ppm [21].

Fish/Seafood Concentrations: Of the 127 stations reporting heptachlor epoxide in biota in EPA's STORET database, 1.6% contained detectable levels of the chemical [129]. Thirty-two percent of the 588 composite samples of fish from 50 sampling stations in the National Pesticides Monitoring Program in 1967 to 1968 contained detectable quantities of heptachlor epoxide [70]. The positive samples range in concentration from 0.01 to 8.46 ppm by wet weight with a median concentration of 0.04 [70]. Samples from Port Ontario on Lake Ontario and the Hudson River exceeded 1 ppm [70]. Heptachlor epoxide was identified, but not quantified, in fish from 3 of 28 selected watersheds in Minnesota, Wisconsin, Michigan, Illinois and Indiana [84]. Detectable levels of the chemical were found only in Mill Creek, Cincinnati, OH, White River, Petersburg, IN, and Stoney Island in Lake Ontario in 1979 [84]. Seven species of fish from Lakes Saint Clair and Erie in 1976 contained mean residues of heptachlor epoxide of 3 to 15 ppb [48]. Concentrations of heptachlor epoxide did not exceed the detection limit of 4 ppb in carp and bluegills from 8 sites in the San Joaquin Valley in California [119].

Heptachlor Epoxide

As part of the National Pesticides Monitoring Program, residues of pesticides in 1524 composite samples of juvenile fish in 144 estuaries in 19 coastal states were analyzed from 1972 to 1976 [16]. Heptachlor epoxide was only reported in Maryland, having a 2% incidence there. In the Petrowatch program in which resident mussels (Mytilus californianus) were taken from 11 intertidal sites along the Californian coast near Monterey Bay, residues from only one site, Ano Nuevo island [1.4 ppb], was above the 0.9 ppb detection limit [99]. No heptachlor epoxide was reported in the 1965 to 1972, 15 state national monitoring program of estuarine mollusks or the follow up program in 1977, although it was routinely screened [15,17]. Heptachlor epoxide has been found in fish from pristine regions. For example, spawn from plankton-feeding Arctic char and from high Alpine lakes whose only input is from the air had residues of 5 ppb on a lipid basis, and fish livers from the Antarctic had residues of 0.02 ppb [6]. In 1984, heptachlor and heptachlor epoxide combined were detected in cyprinid fish (Barbus xanthopterus) from the Shatt al-Arab River, Iraq at concentrations ranging from undetected levels to 13 ppb [34]. In March to June, 1986, heptachlor epoxide was detected in black bullhead, bleak, chub, common carp, eel and tench from the Garigliano River in Southern Italy at average concentrations of 10, 5, 10, 5, 5 and 5 ng/g with an overall frequency of occurrence of 100% [3]. Heptachlor epoxide was detected in black bullhead, bleak, chub, common carp, eel and tench from the Volturno River in Southern Italy at average concentrations of 10, 5, 12, 10, 11, and 5 ng/g with an overall frequency of occurrence of 100% [3]. Heptachlor epoxide was detected in Black Bullhead, Bleak, Chub, Common Carp, Eel and Tench from the Calore River in Southern Italy at average concentrations of 9, 8, 16, 7, 10, and 10 ng/g with an overall frequency of occurrence of 100% [3]. Heptachlor epoxide was detected in Black Bullhead, Bleak, Chub, Common Carp, Eel and Tench from the Sele River in Southern Italy at average concentrations of 15, 5, 10, 5, 5, and 5 ng/g with an overall frequency of occurrence of 100% [3]. Heptachlor epoxide was detected in Coho salmon from the Huron River, Lake Huron at concentrations of 0.01 ug/g in 1984 [30]. Heptachlor epoxide was detected in common carp, channel catfish, smallmouth and largemouth bass, rock bass, pumpkinseed, bowfin, lake trout and northern pike from Lake Michigan collected at White Lake and the St Joseph, Kalamazoo, Grand, Muskegon, Pere Marquette, Manistee, Platte, Boardman, Grand Traverse, Manistique, Whitefish, Escanaba and Ford Rivers at concentrations ranging from

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Heptachlor Epoxide

0.0001 to 0.062 mg/kg wet weight [18]. Heptachlor epoxide was detected in 7 of 8 common carp and 10 of 12 white bass from Tuttle Creek Lake, Kansas at average concentrations of 0.008 and 0.005 ug/kg [4]. The respective mean and maximum heptachlor epoxide concentrations were 0.095 and 0.120 ppm with a frequency of detection of 2 of 3 samples in catfish (Clarius lazero) collected from June to September, 1985 at Beni-Suef Governorate, Egypt [33]. The heptachlor epoxide concentration was 0.010 ppm with a frequency of detection of 1 of 3 samples in Bolti fish (Tilapia nilotica) collected from June to September, 1985 at Beni-Suef Governorate, Egypt [33]. Different fish species from Abu Qir Bay, Idku Lake, and Maryut Lake in Alexandria, Egypt, were assayed for residues of organochlorine insecticides and polychlorinated biphenyls (PCBs). The fish were obtained from commercial fishermen in 1985 and include the following species: Pagellus erythrinus, Sargus vulgaris, Siganus rivulatus, Sphyraena sphyraena, and Trigla hirundo from Abu Qir Bay; and Tilapia fish from Idku and Maryut Lakes. Twenty grams of dorsal fish muscle were extracted and the residues analyzed by GLC. Reagent blanks and spiked samples were included with each sample. The waters from which the fish were obtained receive drainage from industrial, agricultural and urban activities. Water samples were not assayed for specific components. Heptachlor epoxide was detected in all fish in the study. The highest levels of 9.2 ug/kg) were found in Sphyraena sphyraena. From a health standpoint, all samples were well below permissible levels for heptachlor epoxide [39]. Heptachlor epoxide was detected in fish collected from Great Lake harbors and tributary mouths at the Astabula and Black Rivers, Ohio; Sheboygan, Memonimee, Kinnickinnic, Fox and Wolf Rivers, Wisconsin; and Chequamegon Bay, Lake Superior, Wisconsin at concentrations ranging from less than 0.002 mg/kg to 0.048 mg/kg [31]. Heptachlor and heptachlor epoxide combined was detected in the Chinook salmon eggs from Lake Michigan in 1981 at concentrations ranging from 5.8 to 56.3 ug/kg with a respective mean and median concentrations of 27.9 and 25.1 ug/kg [55].

Animal Concentrations: Heptachlor epoxide was detected in double-crested cormorant collected in Atlantic Canada during 1968 to 1984 at concentrations ranging from undetected levels to 0.09 ppm [112]. Heptachlor epoxide was detected in Atlantic Puffin collected in Atlantic Canada during 1968 to 1984 at concentrations ranging from 0.01 to 0.03 ppm [112]. Heptachlor epoxide was detected in Leach's storm petrel

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collected in Atlantic Canada during 1968 to 1984 at concentrations ranging from 0.01 to 0.02 ppm [112]. Heptachlor epoxide was detected in the whole body tissues of 11 of 13 American black ducks (Anas rubripes) collected in Montana in 1981 at concentrations ranging from undetected levels to 5.5 ppm with an average of 0.72 ppm [66]. Heptachlor epoxide was detected in 8 of 8 samples of the whole body tissue of Dunlins (Calidris alpina), a winter prey of peregrine falcons, collected in Samish Bay, Washington in 1980 at concentrations ranging from 0.01 to 0.09 ppm with an average of 0.03 ppm wet weight [121]. Heptachlor epoxide was detected in 5 of 5 samples of the whole body tissue of Dunlins (Calidris alpina), a winter prey of peregrine falcons, collected in Bowerman Basin, Washington in 1980 at concentrations ranging from 0.001 to 0.01 ppm with an average of 0.004 ppm wet weight [121]. A dead California condor was found to contain 1.1 ppm heptachlor epoxide [145]. Osprey (Pandion haliaetus) eggs collected from 14 states during 1970 to 1979 contained heptachlor epoxide at concentrations ranging from undetected levels to 0.98 ppm fresh weight [144]. Heptachlor epoxide was detected in 2 of 4 eggs of Swainson's hawks (Buteo swainsoni) collected in North and South Dakota in 1975 at concentrations ranging from undetected levels to 0.12 ppm with an average of 0.03 ppm wet weight [133]. Heptachlor epoxide was detected in 5 of 9 eggs of Swainson's hawks (Buteo swainsoni) collected in North and South Dakota in 1979 at concentrations ranging from undetected levels to 0.13 ppm with an average of 0.05 ppm wet weight [133]. Heptachlor epoxide was detected in 1 of 3, 1 of 4, 6 of 8 and 8 of 22 eggs of Ferruginous hawks (Buteo regalis) collected in North and South Dakota in 1975, 1976, 1977 and 1979 at concentrations ranging from undetected levels to 0.95, undetected levels to 1.7, undetected levels to 2.3 and undetected levels to 1.2 ppm with averages of 0.32, 0.42, 0.48 and 0.11 ppm wet weight, respectively [133]. Heptachlor epoxide was detected in the carcass of 6 of 7 gray bats (Myotis grisescens) collected in Boone County, MO in 1982 at concentrations ranging from undetected levels to 2.8 ppm wet weight [23]. Heptachlor epoxide was detected in the carcass of 2 of 2 eastern pipistrelle bats (Pipistrellus subflavus) collected in Boone County, MO in 1982 at concentrations of 1.7 and 0.3 ppm wet weight [23]. Heptachlor epoxide was detected in the carcass of 5 of 7 red bats (Lasiurus borealis) collected in Boone County, MO in 1982 at concentrations ranging from undetected levels to 3.2 ppm wet weight [23]. Otters from the coast of northeastern Alberta, Canada were

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found to contain heptachlor epoxide in their livers at concentrations ranging from undetected levels to 0.003 ug/g wet weight [124]. Heptachlor epoxide was detected in the adipose tissue of Canadian arctic and subarctic polar bears collected from 1982 to 1984 [110]. Adult male raccoons collected at Ark City, Downs, Valley Falls, Blue Rapids, Pratt and Emporia, Kansas from November 21, 1984 to January 31, 1985 contained heptachlor epoxide at concentrations of 0.045, 0.140, 0.580, 0.048, 0.099 and 0.130 mg/kg, respectively [89]. Adult female raccoons collected at Downs, Valley Falls, Blue Rapids and Emporia, Kansas from November 21, 1984 to January 31, 1985 contained heptachlor epoxide at concentrations of 0.350, 0.083, 0.063 and 0.370 mg/kg, respectively [89]. Juvenile male raccoons collected at Ark City, Pratt and Emporia, Kansas from November 21, 1984 to January 31, 1985 contained heptachlor epoxide at concentrations of 0.048, 0.650, and 0.043 mg/kg, respectively [89]. Harbour seals from the Dutch Wadden Sea and white-beaked dolphins from the North Sea contained heptachlor epoxide at concentrations ranging from 0.68 to 1.7 and 0.71 to 1.3 ppm, respectively [117]. The presence of heptachlor epoxide in harbor seals (Phoca vitulina) and white-beaked dolphins (Lagenorhynchus albirostris) was confirmed by chemical derivatization and mass spectrometric analysis [82]. The mean concentrations of heptachlor epoxide in the eggs of herring gulls from colonies in Saginaw Bay, the Detroit River, and the Niagara River were 0.13, 0.08 to 0.10, and 0.09 to 0.12 ppm wet weight, respectively [135]. The concentrations of heptachlor epoxide ranged from 0.01 to 0.19 ppm with a mean concentration of 0.04 ppm wet weight in 27 hatching year Goldeneye ducks that overwintered on the Niagara River between November 30 to December 30, 1984 [43]. The concentrations of heptachlor epoxide ranged from 0.03 to 0.41 ppm with a mean concentration of 0.11 ppm wet weight in 25 adult Goldeneye ducks that overwintered on the Niagara River between November 30 to December 30, 1984 [43]. The concentrations of heptachlor epoxide ranged from 0.19 to 0.27 ppm with a mean concentration of 0.23 ppm wet weight in 24 adult Goldeneye ducks that overwintered on the Niagara River between February 15 to March 15, 1985 [43]. The concentrations of heptachlor epoxide in 5 eggs of peregrine falcons from Arizona in 1978, 1981, 1982, 1982 and 1982 were 0.76, 0.29, 0.27, 0.27 and 0.41 ppm, respectively [40]. The eggs of 10 species of fish-eating birds collected in Green Bay and Lake Michigan during 1975 to 1980 contained mean levels of heptachlor epoxide ranging from not detected

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to 500 ppb wet weight [69]. The eggs of Imperial eagles collected in Spain during 1982 to 1984 contained a mean level of heptachlor epoxide of 0.006 ug/g with a range from undetected levels to 0.020 ug/g wet weight [57]. Results of the nationwide monitoring of organochlorine residues in Starlings for 1982 showed that 54.3% of the 129 pooled sites yielded birds with detectable levels of heptachlor epoxide [14]. The mean level was 0.01 ppm wet weight and the maximum, from Texas, was 0.65 ppm [14]. In 1978, carcasses of bald eagles from 32 states contained heptachlor epoxide with a frequency of occurrence of 36% and a median concentration of 80 ppb wet weight [116]. In 1979, carcasses of bald eagles from 32 states contained heptachlor epoxide with a frequency of occurrence of 35% and a median concentration of 150 ppb wet weight [116]. In 1980, carcasses of bald eagles from 32 states contained heptachlor epoxide with a frequency of occurrence of 42% and a median concentration of 120 ppb wet weight [116]. In 1981, carcasses of bald eagles from 32 states contained heptachlor epoxide with a frequency of occurrence of 29% and a median concentration of 120 ppb wet weight [116]. In a 1980 study of organochlorine contaminants in songbirds at 36 sites in 10 western states, 47% of the individual birds and 16% of the composite samples were positive for heptachlor epoxide with a higher percentage of positive values being obtained for migratory than nonmigratory species and for insectivores than omnivores [32]. Positive mean residues ranged from 0.01 to 0.44 ppm wet weight [32]. From a sampling of pheasants, partridges, and hares in West Germany, 85% contained residues of heptachlor epoxide at an average concentration of 1.530 ppm on a fat basis, although the use of heptachlor was banned in 1980 [13].

Milk Concentrations: Residues of heptachlor/heptachlor epoxide in milk have not declined in the years 1972 to 1981 according to results of an ongoing monitoring program conducted by the Illinois Department of Public Health [131]. Average levels in tank car samples ranged from 0.03 to 0.07 ppm for this period [131]. In a Canadian study, residues of heptachlor epoxide in evaporated milk and prepared baby formula were less than one seventh that in human milk samples [127 ppb](fat basis) [120]. Heptachlor epoxide residue was found in Canadian evaporated milk at a concentration of 5.00 ug/L on fat basis [118]. Heptachlor epoxide was detected in cow's milk from Bern, Bowil, Bowil, Hunzenschwil, Suhr and Rheinfelden, Switzerland at concentrations of

2.1, 2.0, 2.1 mean and 0.311 ppm buffalo's. Governors show a trend 1974-1975 deviation from the geographic 0.07 +/- 0.010 mg/kg concentration whole milk. Alberta, Canada concentration milk fat was [143]. The combined [143]. For 1970, the combined and 0.10 to Germany and heptachlor reported to mg/kg, res:

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2.1, 2.0, 2.1, 3.5, 1.5 and 1.9 ug/g on a fat basis [115]. The respective mean and maximum heptachlor epoxide concentrations were 0.201 and 0.311 ppm with a frequency of detection of 2 of 3 samples in whole buffalo's milk collected from June to September, 1985 at Beni-Suef Governorate, Egypt [33]. Cow's whole milk and evaporated milk did not show a trace of heptachlor epoxide in the FDA Market Basket Survey of 1974-1975 [77]. The average concentrations plus or minus the standard deviation of heptachlor and heptachlor epoxide combined within milk fat from the Northeast, Southeast, Midwest, Southwest and Northwest geographical regions of the United States in 1975 were reported to be 0.07 +/- 0.04 mg/kg, 0.13 +/- 0.21 mg/kg, 0.09 +/- 0.07 mg/kg, 0.07 +/- 0.10 mg/kg and 0.07 +/- 0.10 mg/kg, respectively [143]. The average concentration of heptachlor and heptachlor epoxide combined within whole milk in Kenya for 1979 was listed to be 0.5 ug/L [143]. For Alberta, Canada from 1966 to 1970 and from 1977 to 1978, the average concentrations of heptachlor and heptachlor epoxide combined within milk fat were listed to be 0.002 mg/kg and 0.03 mg/kg, respectively [143]. The average concentration of heptachlor and heptachlor epoxide combined within milk fat in Mexico for 1976 was listed to be 0.01 mg/kg [143]. For France from 1971 to 1972 and Vienna, Austria from 1966 to 1970, the average concentrations of heptachlor and heptachlor epoxide combined within milk fat were reported to range from 0.06 to 1.30 mg/kg and 0.10 to 0.13 mg/kg, respectively [143]. For the Federal Republic of Germany from 1973 to 1974 and 1978, the average concentrations of heptachlor and heptachlor epoxide combined within milk fat were reported to range from 0.03 to 0.37 mg/kg and less than 0.01 to 0.11 mg/kg, respectively [143].

Other Environmental Concentrations: Cossette from sugar beets in Chile, which are used as animal feed, contained heptachlor epoxide at concentrations ranging from 0.003 to 0.18 ppm [111].

Probable Routes of Human Exposure: The general population is primarily exposed to heptachlor epoxide from ingesting food containing residues of the chemical. The food classes most likely to contain residues are milk and dairy products and meat, fish and poultry. The increase in heptachlor epoxide levels in mother's milk after the house was treated with heptachlor on the outside suggests that breathing of the vapors over a period of time, rather than ingestion or dermal contact was the main

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route of exposure in this case [126]. Occupational exposure may also occur via inhalation by people who work closely with heptachlor or chlordane such as insecticide formulations.

Average Daily Intake: AIR INTAKE - insufficient data; WATER INTAKE - insufficient data; FOOD INTAKE: 0.0860, 0.121, 0.467 ug for infants, toddlers, and adults, respectively.

Occupational Exposure:

Body Burdens: MILK: In a national study of chlorinated hydrocarbon insecticide residues in human milk in which 1436 samples were obtained from 163 general hospitals throughout the United States, heptachlor was found in less than 2%, but 63.1% of the samples had its metabolite, heptachlor epoxide at levels above the detection limit, with a mean and standard deviation of 91.4 and 125.2 ppb on a fat adjusted basis, respectively [120]. 13.8% of the samples had heptachlor epoxide residues in excess of 100 ppb and 0.6% had residues in excess of 500 ppb [120]. The mean levels in the southeast were the highest, more than double that from the northwest part of the US [120]. A dozen women following a strict vegetarian diet had mean heptachlor epoxide residues in their milk only 1 to 2% as high as average levels in the national study [71]. The highest level of heptachlor epoxide was always lower in vegetarian milk samples for heptachlor epoxide [71]. A 1967 to 1968 Canadian study reported a mean concentration of 127 ppb (fat basis) in human milk [120]. All 53 samples of human milk in a Pennsylvania study were positive with mean concentrations of 160 ppb [91]. For comparison, 30 samples of human milk from Greece, which completely restricted the use of organochlorine compounds in 1972, averaged 3 ppb on a fat basis [49]. Residues of heptachlor epoxide in 100 samples of mother's milk from a town in the middle west part of Germany ranged from 1-173 ppb (fat base), 30 ppb mean [68]. After her house was treated with heptachlor, the concentration of heptachlor epoxide in the milk of a donor rose to a peak level of 29 ppb on a whole-milk basis in 4 to 5 weeks and then declined to near pretreatment levels after 15 weeks [126]. In a 1979 to 1980 study of organochlorine pesticides in mother's milk in Hawaii, all 50 samples of milk taken from 38 women residents of Oahu, Hawaii and 12 residents of neighboring islands contained heptachlor epoxide [137]. The average concentration of heptachlor epoxide on an extractable

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lipid basis among Oahu residents was 36 ppb with a range of 1 to 67 ppb and the average concentration of heptachlor epoxide on an extractable lipid basis among neighboring island residents was 31 ppb with a range of 15 to 52 ppb [137]. All but three of the households used pesticides at home [137]. Women who consumed more meat in their diet tended to have higher residues in their milk [137]. A national survey of Canada showed women's breast whole milk and milkfat to contain heptachlor epoxide at average concentrations of 0.5 and 13 ppb, respectively, with a 62% frequency of occurrence [29]. The average concentrations of heptachlor epoxide among the whole milk and milkfat of native Canadians were 0.2 and 11 ppb, respectively, with a 61% frequency of occurrence [29]. The average concentrations of heptachlor epoxide among the whole milk of Canadians during 1967, 1970, 1975 and 1982 were 3, 4, 1 and trace quantities for 147, 90, 100 and 210 samples, respectively [104]. Comparisons of heptachlor epoxide concentrations in breast milk among residents of the United States, Canada and West Germany showed respective average values of 55, 15 and 8 ng/g of milkfat [104]. Heptachlor epoxide was found in human milk on a fat basis at a concentration of 0.03 ppm [122]. Food by way of food chain is believed to have been the source [122]. PLACENTA: Heptachlor and heptachlor epoxide combined were found in 2 of 4 human placentas of mothers in Iraq at concentrations of 0.015 and 0.028 mg/kg [2]. ADIPOSE TISSUE: Of the 681 to 683 samples of human adipose tissue collected from the general population via the National Human Adipose Tissue Survey of Fiscal Year 1976, 94.6% samples were positive with the geometric mean and max values of 0.11 and 3.26 ppb on a lipid basis, respectively [87]. This mean level was the same as the one observed for the survey conducted from 1970 through 1974 [86]. Results were very different in the National Human Adipose Tissue Survey of Fiscal Year 1982. Of the 46 composite samples analyzed, 67% had detectable levels of heptachlor epoxide of which 19 had trace levels, 3 exceeded 100 ppb, and the maximum was 310 ppb on a lipid basis [128]. Small surveys of adipose tissue from residents of a heavily agricultural area of northeast Louisiana resulted in geometrical mean heptachlor epoxide residues of 200 and 150 ppb in 1980 and 1984, respectively [73]. Mean residues of heptachlor epoxide in human adipose tissue from Ottawa and Kingston, Ontario were 37 and 35 ppb, respectively [90]. In a similar vein, all 99 samples of human adipose tissue obtained from 9 Canadian provinces contained heptachlor epoxide at concentrations ranging from 4 to 404 ppb wet

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weight with a mean of 37 ppb [103]. The adipose tissue of 92 males and 49 females from 6 Ontario, Canada municipalities were analyzed for 28 organohalogen residues in 1984 [146]. The frequency of occurrence for heptachlor epoxide in human adipose tissue from all 6 communities was 100% [146]. For Cornwall, Ontario, heptachlor epoxide was detected in males and females at concentrations ranging from 6 to 39 ng/g and 3.3 to 39 ng/g with means of 17 and 16 ng/g, respectively, with an overall mean of 16 ng/g [146]. For London, Ontario, heptachlor epoxide was detected in males and females at concentrations ranging from 7.9 to 109 ng/g and 6.9 to 107 ng/g with means of 42 and 46 ng/g, respectively, with an overall mean of 44 ng/g [146]. For St Catharines, Ontario, heptachlor epoxide was detected in males and females at concentrations ranging from 8.6 to 150 ng/g and 4.9 to 76 ng/g with means of 45 and 35 ng/g, respectively, with an overall mean of 42 ng/g [146]. For Toronto, Ontario, heptachlor epoxide was detected in males and females at concentrations ranging from 13 to 33 ng/g and 12 to 41 ng/g with both means at 24 ng/g [146]. For Welland, Ontario, heptachlor epoxide was detected in males and females at concentrations ranging from 2 to 84 ng/g and 8.6 to 50 ng/g with means of 23 and 25 ng/g, respectively, with an overall mean of 24 ng/g [146]. For Windsor, Ontario, heptachlor epoxide was detected in males and females at concentrations ranging from 6.5 to 103 ng/g and 8.4 to 100 ng/g with means of 34 and 36 ng/g, respectively, with an overall mean of 35 ng/g [146]. For all six Ontario communities combined, heptachlor epoxide was detected in males and females at concentrations ranging from 2 to 150 ng/g and 3 to 107 ng/g with both means and an overall mean of 33 ng/g [146]. Gas chromatographic analysis indicated an accumulation of organochlorine and PCB insecticides in the adipose tissue of population of Zaire with an average concentration of heptachlor epoxide of 101 ppb [138]. In 1986 to 1987, heptachlor epoxide was detected in all 13 samples of adipose tissue each collected among residents of Osaka Prefecture, Nara Prefecture and Okinawa Prefecture, Japan at average concentrations of 24, 25 and 72 ppb on a fat basis [81]. SERUM: Only 1.1% of the 567 Florida citrus workers surveyed had more than trace quantities of heptachlor epoxide in their serum compared with 3.9% of people in the National Health and Nutrition Examination Survey (NHANES, 4585 samples) [64]. Mean serum residues in the respective surveys were 2.2 and 2.4 ppb [64]. In the NHANES II survey of 1976 to 1980, about 2.5% of the population between 12 and 74 years of age in the Northeast,

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Midwest, and South regions contained heptachlor epoxide in their serum [106]. The median level for quantifiable positives was 1.4 ppb [106]. About 21% of the serum samples from 8 pesticide formulators contained heptachlor epoxide at a mean concentration of 10.9 ppb, while none of the samples from the 4 farmers and 16 members of the control group contained the chemical [130]. A 1984 to 1985 study was performed in Jerusalem, Israel, which compared heptachlor epoxide levels in the serum of infertile males to a control group [113]. Twenty-nine infertile males, between the ages of 25 and 45, with an average age of about 31.5 years, contained heptachlor epoxide at concentrations ranging from 7.0 to 21.7 ng/g with respective mean and median concentrations of 11.64 and 11.9 ng/g [113]. The control group, which was composed of 14 randomly selected males between the ages of 26 to 42 with an average age of about 32.9 years, contained heptachlor epoxide at concentrations ranging from 3.0 to 15.8 ng/g with respective mean and median concentrations of 8.31 and 7.4 ng/g [113].

REFERENCES

1. Al-Omar MA et al; Bull Environ Contam Toxicol 34: 509-12 (1985)
2. Al-Omar MA et al; Environ Pollut Series A 42: 79-91 (1986)
3. Amodio-Cocchieri R, Arnesi A; Bull Environ Contam Toxicol 40: 233-9 (1988)
4. Arruda JA et al; Bull Environ Contam Toxicol 41: 617-24 (1988)
5. Atkinson R; Intern J Chem Kin 19: 799-828 (1987)
6. Ballschmiter K, Zell M; Intern J Environ Anal Chem 8: 15-35 (1980)
7. Benson WR et al; J Agric Food Chem 19: 857-62 (1971)
8. Biberhofer J, Stevens RJJ; Organochlorine Contaminants in Ambient Waters of Lake Ontario. Sci Ser Inland Waters/Lands Dir Canada No 159 p 11 (1987)
9. Biddleman TF et al; Atmos Environ 21: 641-54 (1987)
10. Biggar JW, Riggs RI; Hilgardia 42: 383-91 (1974)
11. Bowman MC et al; J Agric Food Chem 13: 360-5 (1965)
12. Brooksbank P; The Canadian Network For Sampling Organic Compounds In Precipitation Tech Bull No 129 Ottawa, Canada: Environment Canada, Inland Waters Directorate Water Quality Branch p 49 (1983)
13. Brunn H et al; Bull Environ Contam Toxicol 34: 527-32 (1985)
14. Bunck CM et al; Environ Monit Assess 8: 59-75 (1987)
15. Butler PA; Pestic Monit J 6: 238-362 (1973)
16. Butler PA, Schutzmann RL; Pest Monitor J 12: 51-9 (1978)
17. Butler PA et al; Pestic Monit J 12: 99-101 (1978)
18. Camanzo J et al; J Great Lakes Res 13(3): 296-309 (1987)
19. Carey AE et al; Pestic Monit J 6: 369-76 (1973)
20. Carey AE et al; Pestic Monitor J 13: 17-22 (1979)
21. Carey AE et al; Pest Monit J 12: 117-36 (1978)

Heptachlor Epoxide

22. Chen CH, Kohli J; *Sci Ser Can Inland Waters Dir* 158: 1-10 (1987)
23. Clawson RL, Clark DR Jr; *Bull Environ Contam Toxicol* 42: 431-37 (1989)
24. Cohen JM, Pinkerton C; *Adv Chem Ser* 60: 163-76 (1966)
25. Cohen SZ et al; *Ground Water Monit Rev* 10: 160-73 (1990)
26. Cole RH et al; *J Water Pollut Control Fed* 56: 898-908 (1984)
27. Colombo JC et al; *Environ Sci Technol* 24: 498-505 (1990)
28. Davies K; *Chemosphere* 17: 263-76 (1988)
29. Davies D, Mes J; *Bull Environ Contam Toxicol* 39: 743-50 (1987)
30. DeVault DS et al; *J Great Lakes Res* 14: 23-33 (1988)
31. DeVault DS; *Arch Environ Contam Toxicol* 14: 587-94 (1985)
32. DeWeese LR et al; *Environ Toxicol Chem* 5: 675-93 (1986)
33. Dogheim SM et al; *J Assoc Off Anal Chem* 71: 872-4 (1988)
34. DouAbul AAZ et al; *Bull Environ Contam Toxicol* 38: 674-80 (1987)
35. Duggan RE et al; *Pesticide Residue Levels In Foods In The United States From July 1, 1969 To June 30, 1976 Washington, DC: Food Drug Admin Div Chem Technol* (1983)
36. Eichelberger JW, Lichtenberg JJ; *Environ Sci Technol* 5: 541-4 (1971)
37. Eisenreich SJ et al; *Environ Sci Technol* 15: 30-8 (1981)
38. Eisenreich SJ et al; *Environ Sci Technol* 23: 1116-26 (1989)
39. El Nabawi A et al; *Arch Environ Contam Toxicol* 16 (6): 689-96 (1987)
40. Ellis DH et al; *Bull Environ Contam Toxicol* 42: 57-64 (1989)
41. Ernst W; *Chemosphere* 6: 731-40 (1977)
42. Feltz HR; pp. 271-87 in *Contam Sed Fate Transport Case Studies Model Toxicol I Ann Arbor, MI: Ann Arbor Science* (1980)
43. Foley RE, Batcheller GR; *J Wildl Manage* 52: 441-5 (1988)
44. Fox ME et al; *Marine Pollut Bull* 19: 333-6 (1988)
45. Frank R et al; *J Environ Qual* 11: 497 (1982)
46. Frank R; *J Great Lakes Res* 7: 440-54 (1981)
47. Frank R et al; *Can J Soil Sci* 56: 463-84 (1976)
48. Frank R et al; *Pestic Monit J* 12: 69-80 (1978)
49. Fytianos K et al; *Bull Environ Contam Toxicol* 34: 504-8 (1985)
50. Gartrell MJ et al; *J Assoc Off Anal Chem* 69: 123-45 (1986)
51. Gartrell MJ et al; *J Assoc Off Anal Chem* 68: 1163-83 (1985)
52. Gartrell MJ et al; *J Assoc Off Anal Chem* 68: 1184-97 (1985)
53. Gartrell MJ et al; *Assoc Off Anal Chem* 69: 146-61 (1986)
54. Gartrell MJ et al; *Assoc Off Anal Chem* 68: 842-61 (1985)
55. Giesy JP et al; *J Great Lakes Res* 12: 82-98 (1986)
56. Gillion RJ et al; *USGS Water Supply Paper* 2271 p 26 (1985)
57. Gonzalez LM, Hiraldo F; *Environ Pollut* 51: 241-58 (1988)
58. Graham RE et al; *J Agric Food Chem* 21: 824-34 (1973)
59. Great Lakes Water Quality Board; *An Inventory Of Chemical Substances Identified In The Great Lakes Ecosystem Volume 1 Windsor Ontario, Canada* p 195 (1983)
60. Great Lakes Water Quality Board; *1987 Report on Great Lakes Water Quality, Appendix B, Great Lakes Surveillance Volume II* (1989)
61. Green DR et al; *Marine Poll Bull* 17: 324-30 (1986)
62. Greenberg M
63. Gregor DJ, C
64. Griffith J, D
65. Guicherit R.
66. Hall RJ et al
67. Harlley DM.
68. Heesch W
Assoc Vet Pl
CT: AVI (19
69. Heinz GH et
70. Henderson C
71. Hergenrath
72. Hill DW, M
73. Holt RL et a
74. Huang JC; E
75. IARC: Mono
Humans. Sor
76. Ivie GW et a
77. Johnson RD.
78. Johnson RD
79. Johnson RD
80. Kahunyo JM
81. Kashimoto T
82. Kerkhoff M
83. Kraybill HF:
84. Kuehl DW e
85. Kuntz KW, "
86. Kutz FW et :
Pesticides an
pp 95-136 (1
87. Kutz FW; R:
88. Lang JT et a
89. Layher WG
90. Lebel GL, W
91. Lu PY et al:
92. Luke MA et
93. Lyman WJ e
of Chem Pro
94. Mabey WR
USEPA-440,
95. MacMonegle
96. Maddy KT e
97. Maguire RJ
98. Mansour M.
99. Martin M, C
100. McDougall F

Heptachlor Epoxide

62. Greenberg M et al; Environ Sci Technol 16: 14-9 (1982)
63. Gregor DJ, Glimmer WD; Environ Sci Technol 23: 561-5 (1989)
64. Griffith J, Duncan RC; Bull Environ Contam Toxicol 35: 411-7 (1985)
65. Guicherit R, Schulting FL; Sci Total Environ 43: 193-219 (1985)
66. Hall RJ et al; Environ Monit Assess 13: 11-9 (1989)
67. Hartley DM, Johnston JB; Bull Environ Contam Toxicol 31: 33-40 (1983)
68. Heesch W, Bluethgen A; pp 609-23 in Vet Pharmacol Toxicol, Proc Dur Assoc Vet Pharmacol Toxicol, 2nd Congress Ruckebusch, Y et al eds Westport, CT: AVI (1983)
69. Heinz GH et al; Environ Monit Assess 5: 223-36 (1985)
70. Henderson C et al; Pestic Monit J 3: 145-71 (1969)
71. Hergenrather J et al; New England J. Medicine 304: 792 (1981)
72. Hill DW, McCarty PL; J Water Pollut Contr Fed 39: 1259-77 (1967)
73. Holt RL et al; Bull Environ Contam Toxicol 36: 651-5 (1986)
74. Huang JC; Eng Bull Purdue Univ Eng Ext Series 1970, pp 449-57 (1970)
75. IARC; Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans. Some Halogenated Hydrocarbons. 20: 129-54 (1979)
76. Ivie GW et al; Bull Environ Contam Toxicol 7: 376-82 (1972)
77. Johnson RD, Manske DD; Pest Monit J 11: 116 (1977)
78. Johnson RD et al; Pestic Monit J 15: 39-50 (1981)
79. Johnson RD et al; J Assoc Off Anal Chem 67: 145-54 (1984)
80. Kahunyo JM et al; Poultry Sci 65: 1084-9 (1986)
81. Kashimoto T et al; Chemosphere 19: 921-6 (1989)
82. Kerkhoff M et al; Sci Total Environ 19(1): 41-50 (1981)
83. Kraybill HF; NY Academy Of Sci Annals 298: 80-9 (1977)
84. Kuehl DW et al; Environ Int 9: 293-9 (1983)
85. Kuntz KW, Warry ND; J Great Lakes Res 9: 241-8 (1983)
86. Kutz FW et al; National Pesticide Monitoring Programs IN: Air Pollution from Pesticides and Agricultural Processes Lee, RE Jr ed Cleveland, OH: CRC Press pp 95-136 (1976)
87. Kutz FW; Res Rev 85: 277-92 (1983)
88. Lang JT et al; Pestic Monit J 12: 230-3 (1979)
89. Layher WG et al; Bull Environ Contam Toxicol 39: 926-32 (1987)
90. Lebel GL, Williams DT; J Assoc Off Anal Chem 69: 451-8 (1986)
91. Lu PY et al; J Agric Food Chem 23: 967-73 (1975)
92. Luke MA et al; J Assoc Off Anal Chem 71: 415-20 (1988)
93. Lyman WJ et al; pp 4-1 to 4-33, pp 5-1 to 5-30, pp 15-1 to 15-34 in Handbook of Chem Property Estimation Methods. McGraw-Hill NY (1982)
94. Mabey WR et al; Aquatic Fate Process Data For Organic Priority Pollutants USEPA-440/4-81-014 p 434 (1981)
95. MacMonegle CW Jr et al; J Environ Sci Health B 19: 39-48 (1984)
96. Maddy KT et al; Bull Environ Contam Toxicol 29: 354-9 (1982)
97. Maguire RJ et al; J Great Lakes Res 9: 281-6 (1983)
98. Mansour M, Parlar H; J Agric Food Chem 26: 483-5 (1978)
99. Martin M, Castle W; Mar Pollut Bull 15: 259-66 (1984)
100. McDougall KW et al; Bull Environ Contam Toxicol 39: 286-93 (1987)

Heptachlor Epoxide

101. McFall JA et al; Chemosphere 14: 1253-65 (1985)
102. McLeod HA et al; J Food Safety 2: 141-64 (1980)
103. Mes J et al; Bull Environ Contam Toxicol 28: 97-104 (1982)
104. Mes J et al; Food Additives and Contaminants 3: 313-22 (1986)
105. Miles JRW et al; J Econ Entomol 64: 839-41 (1971)
106. Murphy R, Harvey C; Environ Health Perspect 60: 115-20 (1985)
107. Nash RG; J Agric Food Chem 31: 210-7 (1983)
108. Nash RG; Res Rev 85: 199-216 (1983)
109. Nash RG; J. Agric Food Chem 31: 1195-201 (1983)
110. Norstorm RJ et al; Environ Sci Technol 22: 1063-71 (1988)
111. Ober AG et al; Bull Environ Contam Toxicol 38: 404-8 (1987)
112. Pearce PA et al; Environ Pollut 56: 217-35 (1989)
113. Pines A et al; Arch Environ Contam Toxicol 16: 587-97 (1987)
114. Poulton DJ; J Great Lakes Res 13: 193-202 (1987)
115. Rappe C et al; Environ Sci Technol 21: 964-70 (1987)
116. Reichel WL et al; Env Monit Assess 4: 395-403 (1984)
117. Reish DJ et al; J Water Pollut Control Fed 54: 786-812 (1982)
118. Ritcey WR et al; Can J Publ Health 63: 125 (1972)
119. Saiki MK, Schmitt CJ; Arch Environ Contam Toxicol 15: 357-66 (1986)
120. Savage EP et al; Am J Epidemiology 113: 413-22 (1981)
121. Schick C et al; Environ Monit Assess 9: 115-31 (1987)
122. Schuepbach MR; Mitt Geb Lebensmittelunters Hyg 72: 2-21 (1981)
123. Shackelford WM et al; Analyt Chim Acta 146: 15-27 (1983)
124. Somers JD et al; Bull Environ Contam Toxicol 39: 783-90 (1987)
125. Spalding RF et al; Pestic Monit J 14: 70-3 (1980)
126. Stacey CI, Tatum T; Bull Environ Contam Toxicol 35: 202-8 (1985)
127. Stanley CW et al; Environ Sci Tech 5: 430-5 (1971)
128. Stanley JS; Broad Scan Analysis of the FY82 National Human Adipose Tissue Survey Specimens USEPA-560/5-860-037 (1986)
129. Staples CA et al; Environ Toxicol Chem 4: 131-42 (1985)
130. Starr HG JR et al; Pestic Monit J 8: 209-12 (1974)
131. Steffey KL et al; J Environ Sci Health B 19: 49-65 (1984)
132. Steichen J et al; Ground Water Monit Rev 8: 153-9 (1988)
133. Stendell RC et al; Environ Monit Assess 10: 37-41 (1988)
134. Strachan WMJ; Environ Toxicol Chem 4: 677-83 (1985)
135. Struger J et al; J Great Lakes Res 11: 223-30 (1985)
136. Tabak HH et al; J Water Pollut Contr Fed 53: 1503-18 (1981)
137. Takahasi, W et al; Bull Environ Contam Toxicol 27: 506-11 (1981)
138. Tite M et al; J Toxicol Med 2: 259-64 (1982)
139. USEPA/ODW; Health Advisory: Heptachlor and Heptachlor Epoxide (Draft) p 3 (1985)
140. USEPA; Ambient Water Quality Criteria Doc: Heptachlor p.C-6 EPA 440/5-80-052 (1980)
141. Veith GD et al; J Fish Res Board Can 36: 1040-8 (1979)
142. Warner HP et al; Determination of Henry's Law Constants of Selected Priority Pollutants EPA/600/D-87/229; NTIS PB87-212684 (1987)

143. WHO; Env
144. Wiemeyer.
145. Wiemeyer.
146. Williams D
147. Worthing C
Protection
148. Zaroogian
149. Zoeteman

Heptachlor Epoxide

- 143. WHO; Environ Health Criteria: Heptachlor p 25-29 (1984)
- 144. Wiemeyer, SN et al. 1988; Arch Environ Contam Toxicol 17: 767-87 (1988)
- 145. Wiemeyer, SN et al. 1988; Wildl Manage 52: 238-47 (1988)
- 146. Williams DT et al; J Assoc Off Anal Chem 71: 410-4 (1988)
- 147. Worthing CR; The Pesticide Manual 7th ed Croydon, England: The British Crop Protection Council p 306 (1983)
- 148. Zarogian GE et al; Environ Toxicol Chem 4: 3-12 (1985)
- 149. Zoeteman BCJ et al; Chemosphere 9: 231-49 (1980)

" Analytical Results of Sample "

IT. 1990. International Technology Corporation Analytical Services. "Analytical Results of Sample". September 24.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



RSB 100-11-90
File: Special waste,
Knox Co.

TELECOPY # 573-9546

TO: Smoky mtn. Smelters

FROM: Kim Laisy

DATE: 9-24-90

PAGE: 1 OF 14

- ☐ DISCARD WHEN SENT
☐ PLEASE RETURN

CONTACT:

RECEPTIONIST
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN 37921
615-588-6401

NOTES: Copy sent to Waste Management

Regional Office

5815 Middlebrook Pike • Knoxville, Tennessee 3 921 • 615-588-6401

IT Corporation is a wholly owned subsidiary of International Technology Corporation



ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

Waste Management Inc., Knoxville
P.O. Box 12209
Knoxville, TN 37912
ATTN: Larry Tackett

September 24, 1990

Job Number: WMIK 46378

P.O. Number: NA

This is the Certificate of Analysis for the following sample:

Client Project ID: Smokey Mtn. Smelters
Date Received by Lab: 08/13/90
Number of Samples: One (1)
Sample Type: Solid

METALS ANALYSIS

Results in mg/liter (ppm) in the extract

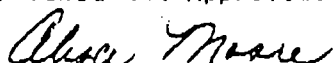
Client Sample ID:	Method Blank/TCLP Blank	Smokey Mtn. Smelters
Lab Sample ID:	PBE0045	LL5296
arsenic	0.03 U	0.42
barium	0.002 U	0.72
cadmium	0.005 U	0.005 U
chromium	0.01 U	0.38
lead	0.03 U	0.03 U
mercury	0.001 U	0.001 U
selenium	0.06 U	0.06 U
silver	0.005 U	0.005 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

Date Extracted: 08/23/90 Date Digested: 09/02/90
Date Analyzed: 09/13/90 (ICP); 08/27/90 (CVAA)

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 11363-11875.

Reviewed and Approved:


Alyce Moore
Laboratory Manager

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

CLASSICAL PARAMETERS ANALYSIS

Results in mg/kg (ppm) unless otherwise stated

Sample Matrix: Solid

Client Sample ID: Lab Sample ID:	Smokey Mtn. Smelters <u>LL5296</u>	Analysis Date
pH (standard units)	8.05	08/17/90
% Solids (%)	98.5	08/17/90
Filter Paint Test	No Free Liquids	08/17/90
Specific Gravity	2.300	08/17/90

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

REACTIVITY, AS CYANIDE AND SULFIDE

Results in mg/kg (ppm)

Sample Matrix: Solid

Client Sample ID: Lab Sample ID:	Method Blank <u>P1434/P1420</u>	Smokey Mtn. Smelters <u>LL5296</u>	Analysis Date
Cyanide	0.5 U	0.5 U	08/21/90
Sulfide	80 U	80 U	08/15/90

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP VOLATILE COMPOUNDS

Results in ug/liter (ppb) in the extract

Sample Matrix: Solid

Client Sample ID: Method Blank
Lab Sample ID: EB0904

Compound

acrylonitrile	10 U
benzene	5 U
carbon disulfide	5 U
carbon tetrachloride	5 U
chlorobenzene	5 U
chloroform	1 J
1,2-dichloroethane	5 U
1,1-dichloroethene	5 U
isobutanol	2,000 U
methylene chloride	2 J
methyl ethyl ketone	10 U
1,1,1,2-tetrachloroethane	5 U
1,1,2,2-tetrachloroethane	2 J
tetrachloroethene	5 U
toluene	5 U
1,1,1-trichloroethane	5 U
1,1,2-trichloroethane	5 U
trichloroethene	5 U
vinyl chloride	10 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

J - Indicates an estimated value less than the detection limit.

Date Analyzed: 09/04/90

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 11863-11875.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP VOLATILE COMPOUNDS

Results in µg/liter (ppb) in the extract

Sample Matrix: Solid

Client Sample ID: TCLP Blank
Lab Sample ID: C0056

Compound

acrylonitrile	10 U
benzene	5 U
carbon disulfide	5 U
carbon tetrachloride	5 U
chlorobenzene	5 U
chloroform	5 U
1,2-dichloroethane	5 U
1,1-dichloroethene	5 U
isobutanol	2,000 U
methylene chloride	2 J
methyl ethyl ketone	38
1,1,1,2-tetrachloroethane	5 U
1,1,2,2-tetrachloroethane	5 U
tetrachloroethene	5 U
toluene	5 U
1,1,1-trichloroethane	5 U
1,1,2-trichloroethane	5 U
trichloroethene	5 U
vinyl chloride	10 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

J - Indicates an estimated value less than the detection limit.

TCLP Extracted: 08/28/90

Date Analyzed: 09/04/90

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 11863-11875.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP VOLATILE COMPOUNDS

Results in ug/liter (ppb) in the extract

Sample Matrix: Solid

Client Sample ID: Smokey Mtn. Smelters
Lab Sample ID: LL5296

Compound

acrylonitrile	10 U
benzene	5 U
carbon disulfide	7
carbon tetrachloride	5 U
chlorobenzene	5 U
chloroform	2 J
1,2-dichloroethane	5 U
1,1-dichloroethene	5 U
isobutanol	2,000 U
methylene chloride	1 J
methyl ethyl ketone	11
1,1,1,2-tetrachloroethane	5 U
1,1,2,2-tetrachloroethane	5 U
tetrachloroethene	5 U
toluene	8
1,1,1-trichloroethane	5 U
1,1,2-trichloroethane	5 U
trichloroethene	5 U
vinyl chloride	10 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

J - Indicates an estimated value less than the detection limit.

TCLP Extracted: 08/28/90
Date Analyzed: 09/04/90

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 11863-11875.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

WATER SURROGATE PERCENT RECOVERY SUMMARY

Sample No.	VOLATILE		
	Toluene-D8 (88-110%)*	BFB (86-115%)*	1,2 Dichloroethane-D4 (76-114%)*
Method Blank	93	92	97
TCLP Blank	87	88	83
Smokey Mtn. Smelters	87	89	86

* - Values in parenthesis represent USEPA contract required QC limits.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP SEMIVOLATILE COMPOUNDS

Results in µg/liter (ppb) in the extract

Sample Matrix: Solid

Client Sample ID: Method Blank
Lab Sample ID: BLA1580

Compound

bis(2-chloroethyl)ether	10 U
o-cresol	10 U
m-cresol	10 U
p-cresol	10 U
1,2-dichlorobenzene	10 U
1,4-dichlorobenzene	10 U
2,4-dinitrotoluene	10 U
hexachlorobenzene	10 U
hexachlorobutadiene	10 U
hexachloroethane	10 U
nitrobenzene	10 U
pentachlorophenol	50 U
phenol	10 U
pyridine	100 U
2,3,4,6-tetrachlorophenol	10 U
2,4,5-trichlorophenol	50 U
2,4,6-trichlorophenol	10 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

J - Indicates an estimated value less than the detection limit.

TCLP Extracted: 08/23/90
Date Extracted: 08/23/90
Date Analyzed: 08/27 - 09/04/90

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 1.863-11875.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
6815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP SEMIVOLATILE COMPOUNDS

Results in ug/liter (ppb) in the extract

Sample Matrix: Solid

Client Sample ID: TCLP Blank
Lab Sample ID: E0040

Compound

bis(2-chloroethyl)ether	10 U
o-cresol	10 U
m-cresol	10 U
p-cresol	10 U
1,2-dichlorobenzene	10 U
1,4-dichlorobenzene	10 U
2,4-dinitrotoluene	10 U
hexachlorobenzene	10 U
hexachlorobutadiene	10 U
hexachloroethane	10 U
nitrobenzene	10 U
pentachlorophenol	50 U
phenol	10 U
pyridine	100 U
2,3,4,6-tetrachlorophenol	10 U
2,4,5-trichlorophenol	50 U
2,4,6-trichlorophenol	10 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

J - Indicates an estimated value less than the detection limit.

TCLP Extracted: 08/23/90
Date Extracted: 08/23/90
Date Analyzed: 08/27 - 09/04/90

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 11163-11875.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP SEMIVOLATILE COMPOUNDS

Results in µg/liter (ppb) in the extract

Sample Matrix: Solid

Client Sample ID: Smokey Mtn. Smelters
Lab Sample ID: LL5296

Compound

bis(2-chloroethyl)ether	10 U
o-cresol	10 U
m-cresol	10 U
p-cresol	10 U
1,2-dichlorobenzene	10 U
1,4-dichlorobenzene	10 U
2,4-dinitrotoluene	10 U
hexachlorobenzene	10 U
hexachlorobutadiene	10 U
hexachloroethane	10 U
nitrobenzene	10 U
pentachlorophenol	50 U
phenol	10 U
pyridine	100 U
2,3,4,6-tetrachlorophenol	10 U
2,4,5-trichlorophenol	50 U
2,4,6-trichlorophenol	10 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

J - Indicates an estimated value less than the detection limit.

TCLP Extracted: 08/23/90
Date Extracted: 08/23/90
Date Analyzed: 08/27 - 09/04/90

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 11363-11875.

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Waste Management Inc., Knoxville
September 24, 1990

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

WATER SURROGATE PERCENT RECOVER SUMMARY

Sample No.	SEMI-VOLATILE					
	Nitro- Benzene-D5 (35-114%)*	2-Fluoro- Biphenyl (43-116%)*	Terphenyl- D14 (33-141%)*	Phenol-D5 (10-94%)*	2-Fluoro- Phenol (21-100%)*	2,4,6 Tribromo- Phenol (10-123%)*
TCLP Blank	80	74	86	30	55	94
Smokey Mtn. Smelters	73	62	87	15	28	63
Method Blank	76	77	88	30	49	91

* - Values in parenthesis represent USEPA contract required QC limits.

Waste Management Inc., Knoxville
September 24, 1990

IT ANALYTICAL SERVICES
5815 MIDDLEBROOK PIKE
KNOXVILLE, TN

Client Project ID: Smokey Mtn. Smelters

Job Number: WMIK 46378

TCLP PESTICIDES AND HERBICIDES

Results in mg/liter (ppm) in the extract

Sample Matrix: Solid

Client Sample ID: Lab Sample ID:	TCLP Blank E0042	Smokey Mtn. Smelters LL5296	TCLP Blank E0041	Method Blank BLA1596/BLA1582
lindane	0.0001 U	0.0001 U	0.0001 U	0.0001 U
endrin	0.0001 U	0.0001 U	0.0001 U	0.0001 U
heptachlor	0.0001 U	0.0001 U	0.0001 U	0.0001 U
heptachlor epoxide	0.0001 U	0.0001 U	0.0001 U	0.0001 U
methoxychlor	0.0001 U	0.0001 U	0.0001 U	0.0001 U
chlordan	0.0004 U	0.0004 U	0.0004 U	0.0004 U
toxaphene	0.0004 U	0.0004 U	0.0004 U	0.0004 U
2,4-D	0.0002 U	0.0003 U*	0.0002 U	0.0002 U
2,4,5-TP (Silvex)	0.0001 U	0.0002 U*	0.0001 U	0.0001 U

U - Compound was analyzed for but not detected. The number is the detection limit for the sample.

* - Higher detection limit due to matrix interferences.

Sample extracted in accordance with the, "Toxicity Characteristic Leaching Procedure," Federal Register, Vol. 55, No. 61, pp. 1863-11875.

TCLP Extracted: 08/23/90
Date Extracted: 08/27/90
Date Analyzed: 08/31 and 09/10/90

HARRY W. GALBRAITH, PH.D.
CHAIRMAN OF THE BOARD

KENNETH S. WOODS
PRESIDENT

GAIL R. HUTCHENS
EXECUTIVE VICE-PRESIDENT

VELMA M. RUSSELL
SECRETARY/TREASURER

GALBRAITH

Laboratories, Inc.

QUANTITATIVE MICROANALYSES
ORGANIC - INORGANIC
615/546-1335

P.O. BOX 51610
KNOXVILLE, TN 37950-1610

2323 SYCAMORE DR.
KNOXVILLE, TN 37921-1750

Ms. Kim Laisy
IT Corporation
5815 Middlebrook Pike
Knoxville, Tennessee 37921

August 17, 1990

Received: Aug. 13th
Proj. #: WMIK46378
PO #: 532116

Dear Ms. Laisy:

Analysis of your compound gave the following results

Your #,	Our #,	Flash Point(Tag Closed Cap),	Date Analyzed & Prepped,
LL5297	N-0586	No flash below 145°F	8/14/90
Smokey Mtn. Smelters Test flame extinguished above 97°F, had a halo at all temperatures.			

Sincerely yours,

GALBRAITH LABORATORIES, INC.

Gail R. Hutchens/GRH

Gail R. Hutchens,
Exec. Vice-President

GRH:ew



" Permit Application "

KCDAPC. 1980. Permit Application, Form APC-1. Received by the Knox County
Department of Air Pollution Control, filed by Dan E. Johnson, President,
Smokey Mountain Smelters, Inc. November 7.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

(PLEASE TYPE OR PRINT)

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY
INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY UNDER
WHICH APPLICATION IS SUBMITTED:

SMOKEY MOUNTAIN SMELTERS, INC

2. MAILING ADDRESS

P.O. Box 2704
KNOXVILLE, TN 37901
CITY ZIP CODE

3. ADDRESS AT WHICH SOURCE IS TO BE OPERATED:

455 MARYVILLE PIKE KNOXVILLE, TN 37920
ADDRESS CITY ZIP CODE

4. TYPE OF ORGANIZATION:

CORPORATION



INDIVIDUAL



PARTNERSHIP



GOVERNMENTAL AGENCY



5. BRIEF DESCRIPTION OF OPERATION AT THIS ADDRESS:

ALUMINUM SMELTER (MELTING
OPERATION

6. COST OF AIR POLLUTION CONTROL EQUIPMENT: \$ _____

7. PRESENT STATUS OF AIR CONTAMINANT SOURCE (CHECK AND COMPLETE APPLICABLE ITEMS)

EST. STARTING DATE

EST. COMPLETION DATE



PERMIT TO CONSTRUCT REQUESTED



PERMIT TO OPERATE REQUESTED

AIR CONTAMINANT SOURCES HAVE NOT BEEN
ALTERED

8. SIGNATURE OF RESPONSIBLE MEMBER OF FIRM

Dan E. Johnson

DATE OF APPLICATION

11-7-80

9. TYPE OR PRINT NAME AND OFFICIAL TITLE OF PERSON
SIGNING THIS APPLICATION

NAME DAN E. JOHNSONTITLE PRESIDENTPHONE (615) 577-8986

FOR OFFICE USE ONLY

10. SOURCES PERMITTED

SOURCE
Aluminum Smelter
0514-01

PERMIT NO.

11. TOTAL ACTUAL EMISSIONS (TONS/YR)

PARTICULATE _____

SO₂ _____

NO_x _____

HC _____

CO _____

OTHER _____

**" Facility Inspection Report
David Witherspoon, Inc.
Witherspoon and Johnson Dump "**

KCDAPC. 1983. Facility Inspection Report, David Witherspoon, Inc. - Witherspoon
and Johnson Dump. Inspected by the Knox County Department of Air
Pollution Control, December 5.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

12/10/83

00 12-12-83
Jm 12-12-83
187 12/12/83

5
4

DATE 12/12/83

TIME 2:30 P.M.

13

FACILITY INSPECTION REPORT

[David Witherspoon, Inc.]

FACILITY Witherspoon & Johnson Dump

LOCATION 1455 Mansville Pike

NAME AND TITLE OF PERSON CONTACTED N/A

PURPOSE OF INSPECTION Open Burning Compliance

COMMENTS: Inspector Liddington & I made circuit of dump & perimeter; extensive work had been done in burying everything on the surface, except for some of the slag from the smelting operation.

A small smoke plume was found in the southern portion of the perimeter. (see photo and sketch). The smoke carried a pervasive musty stink. The rest of the dump had the typical ammonia odor.

L.L. and I walked up the south path to the Train tracks; (S.R.R.) to confirm no fencing or any type has been installed. Dump is not fenced in on all sides.

Violation

Recommended NOV to Source; copy to Law Dept, (Judge Cates?)

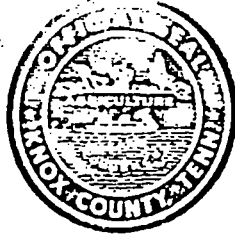
After review w/ JC, decision was made to send NOV to Source with copy to Law Dept LL

INSPECTOR William J. Schoed, III
Lynne Liddington

" Disposal Of Slag From RF/SMS Operations "

KCDAPC. 1984. "Disposal of Slag from RF/SMS operations", memo to L.L., J.C., J.L. (KCAPC), from W. Schaad, dated February 8.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



DEPARTMENT OF AIR POLLUTION CONTROL
ROOM L-222, CITY-COUNTY BUILDING
400 MAIN AVENUE
KNOXVILLE, TENNESSEE 37902

TELEPHONE: 521-

MEMORANDUM

TO: *2-9-84*
2-9-84
2-10-84
DLC, JF, JGC;

FROM: W.S.

DATE: 2/8/84

TIME: 4:15 P.M.

SUBJECT: Disposal of Slog from RF/SMS operations: // asbestos
Jack Crabtree of TN. Div. of Solid Waste ^{Mgmt.} stated that RF/SMS
had agreed to dispose of slog materials @ BFI Landfill.
Stated that he was unsure of asbestos siding at
building (being removed), but that Rick Brown (S.W.M.) is working
with that asbestos issue.

Rotary Furnace,
File: ~~RF~~
Smoky Mountain Sm.
- Conesp.

How do we know
there is asbestos.

asbestos samples were taken from dump behind
Screen acts ~~Screen acts~~, analyzed for asbestos, proved very positive.
- Inc.

See letter from TAPC dated 10/17/83 - asbestos file

" " " KCAAC " 9/19/83 - " "

" Inspection Report, Witherspoon Dump 9/12/83

[over]

note: Though it doesn't appear to be noted elsewhere in file, the old siding on the building (1455 Maryville is this same material. If there is ~~any~~ any doubt (I've none we can have a sample tested by TN. APC.

Note: 2/10/84; 2:10 P.M. Rick Brown of Solid Waste Mgmt stated Jack Crabtree was only person dealing w/ RF/SWS; he has not address asbestos siding to Mr. Johnson or Mr. Wittehouse. Strongly suggest formal letter be sent to SWM to "enlighten" them of potential problem w/ asbestos siding.

" David Witherspoon - Historical Record "

KCDAPC. 1985. "David Witherspoon - Historical Record", Knox County
Department of Air Pollution Control.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

DAVID WITHERSPOON

Historical Record

<u>Date</u>	<u>Location</u>	<u>Nature</u>	<u>Result</u>	<u>File</u>
03-29-85	901 Maryville Pike	Open Burning	No Violation	Inspection
11-16-84	1455 Maryville Pike	Odor	No Violation	Inspection
11-15-84	1455 Maryville Pike	Open Burning	No Violation	Inspection
08-21-84	901 Maryville Pike	Open Burning	Violation	Complaint
04-19-84	1455 Maryville Pike	Open Burning	No Violation	Inspection
04-16-84	1455 Maryville Pike	Open Burning	No Violation	Inspection
04-11-84	1455 Maryville Pike	Open Burning	No Violation	Inspection
03-05-84	1455 Maryville Pike	Open Burning	Violation	Inspection
01-19-84	1455 Maryville Pike	Open Burning	No Violation	Inspection
01-05-84	1455 Maryville Pike	Open Burning	No Violation	Inspection
12-20-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
12-16-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
12-06-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
12-05-83	1455 Maryville Pike	Open Burning	Violation	Inspection
10-01-83	KCAPC Sues David Witherspoon, Jr. and Dan Johnson over open burning at 1455 and 1630 Maryville Pike. Judge sets temporary injunction against any open burning on these properties. Injunction lifted in Spring 1984.			
09-12-83	1455 Maryville Pike	Open Burning	Violation	Complaint
	1630 Maryville Pike	Open Burning	No Violation	Inspection
09-07-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
09-01-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
08-20-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
08-18-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
08-15-83	1455 Maryville Pike	Open Burning	Violation	Inspection
08-11-83	1455 Maryville Pike	Open Burning	Violation	Inspection
08-02-83	1455 Maryville Pike	Open Burning	Violation	Inspection
07-25-83	1630 Maryville Pike	Open Burning	Violation	Complaint
07-12-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
06-29-83	1455 Maryville Pike	Open Burning	Violation	Inspection
06-28-83	1455 Maryville Pike	Open Burning	Violation	Inspection
06-21-83	1455 Maryville Pike	Open Burning	Violation	Inspection
06-06-83	Referred to Knox County Law Dept. for injunctive relief.			
05-24-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
05-16-83	1455 Maryville Pike	Open Burning	No Violation	Complaint
05-12-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
05-11-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
05-10-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
04-27-83	1455 Maryville Pike	Open Burning	Violation	Complaint
04-04-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
03-31-83	1455 Maryville Pike	Open Burning	Violation	Inspection
03-28-83	1455 Maryville Pike	Open Burning	Violation	Inspection
03-22-83	1455 Maryville Pike	Open Burning	Violation	Complaint
03-15-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
03-14-83	1455 Maryville Pike	Open Burning	Violation	Complaint
03-07-83	1455 Maryville Pike	Open Burning	Violation	Complaint
03-04-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
3-03-83	1455 Maryville Pike	Open Burning	No Violation	Inspection

<u>Date</u>	<u>Location</u>	<u>Nature</u>	<u>Result</u>	<u>File</u>
03-02-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-21-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-18-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-17-83	1455 Maryville Pike	Open Burning	Violation	Complaint
02-11-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-09-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-08-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-07-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-04-83	1455 Maryville Pike	Open Burning	No Violation	Inspection
02-03-83	1455 Maryville Pike	Open Burning	Violation	Inspection
02-01-83	1455 Maryville Pike	Open Burning	Violation	Complaint
01-31-83	1455 Maryville Pike	Open Burning	No Violation	Complaint
01-28-83	Letter to David Witherspoon, Jr. from Knox County Law Dept. directing him to take immediate action to remedy the situation or face a possible injunction.			
01-28-83	1455 Maryville Pike	Open Burning	Violation	Inspection
01-27-83	1455 Maryville Pike	Open Burning	Violation	Inspection
01-26-83	1455 Maryville Pike	Open Burning	Violation	Complaint
01-25-83	1455 Maryville Pike	Open Burning	Violation	Complaint
01-24-83	1455 Maryville Pike	Open Burning	Violation	Complaint
01-20-83	1455 Maryville Pike	Open Burning	Violation	Inspection
01-19-83	1455 Maryville Pike	Open Burning	Violation	Complaint

" List Of Complaints, Inspections, And Departmental Action "

KCDAPC. 1989. "List of complaints, inspections, and Departmental action", Knox
County Department of Air Pollution Control, August 10.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

62 8/14/89

SUMMARY REPORT

DATE: 8/10/89

SUBJECT: Chronological list of complaints, inspections and Departmental action concerning Smokey Mountain Smelters from 1/23/89 to 8/10/89.

<u>DATE</u>	<u>TYPE OF EVENT AND ACTION TAKEN</u>
1/23/89	<u>Complaint.</u> Complainant called the Department concerning heavy emissions from S.M.S.
1/23/89	<u>Complaint Inspection.</u> R.J. and I inspected S.M.S. and read V.E.'s at 35%. R.J. noted that emissions were escaping the capture hoods above the rotary kilns. N.O.V. was sent to the source. Turnaround date on A.P.C. 13 form was 2/7/89.
2/15/89	<u>Received A.P.C. 13.</u> A.P.C. 13 form was returned 8 days late. S.M.S. determined that a storm damaged portion of the furnace building was responsible for excessive emissions. The A.P.C. 13 states that repairs were made on 2/10/89.
4/7/89	<u>Complaint.</u> (b) (6) reported excessive smoke from S.M.S.
4/7/89	<u>Complaint Inspection.</u> W.S. and I investigated the complaint. Fugitive emissions was escaping at the roof top and was read at 31%. Video tape and a photograph was taken of the incident. The excessive emissions were attributed to a malfunction of the baghouse. The malfunction was not reported to the Department. W.S. indicated to Mr. Russell the reporting requirements concerning malfunctions of equipment (Reg. 34.0), and that the Department will require a formal correspondence concerning the reason for the malfunction. No N.O.V. was issued.
4/13/89	<u>Correspondence from S.M.S.</u> Mr. Russell sent formal correspondence explaining the malfunction of the baghouse controls. Mr. Russell stated that water seepage clogged (3) bags in the baghouse. The letter indicates that the corrective action taken was the replacement of the (3) bags.
4/24/89	<u>Correspondence from K.C.A.P.C.</u> W.S. sent out formal correspondence asking S.M.S. why the Department was not notified of the 4/7/89

baghouse malfunction and what actions S.M.S. would take in the future to prevent the failure of notifying the Department of a malfunction.

4/28/89

Correspondence from S.M.S. Mr. Russell indicated in a letter to the Department that an illness in the family had prevented him from being on his normal shift. Thus, Mr. Russell had not sufficient time to notify the Department, being he had just arrived. He also stated that shift managers Tommy Edmonds and Mike Daniels would contact the Department concerning a malfunction if he were not available.

5/11/89

Complaint. (b) (6) reported excessive emissions from 9:00 P.M. to 1:30 A.M. on 5/10-11/89. No inspection was made due to the time of complaint. Nighttime surveillance of S.M.S. was discussed.

5/18/89

Complaint. An anonymous complainant reported excessive emissions at 4:25 P.M. No inspection was made due to the time of the complaint. No complaints were reported the following day.

5/24/89

Compliance inspection. The #1 baghouse was being repaired (to correct roof and floor problems). I met with Mr. Glenn Riggs (Purchasing Director) who is the temporary General Manager (Fred Russell is no longer with the company). During my discussion with Mr. Riggs, I brought up two points:

- #1 I made Mr. Riggs aware of the Department's concern about nighttime emissions at S.M.S. I reminded Mr. Riggs that all of the plant operators should be aware of the proper and effective operations of the smelting process and baghouse controls with regard to K.C.A.P.C. Regulations.
- #2 I reminded Mr. Riggs of Regulation 34.0 (Malfunction of Equipment), and that failure to immediately contact the Department concerning a malfunction would violate Regulation 34.0.

6/20/89

Complaint. (b) (6) reported heavy emissions from S.M.S. "all morning" (as reported on the complaint report). He noted that the emissions made it hard to breath.

6/20/89

Complaint inspection. An on-site inspection showed an obvious problem with baghouse control efficiency (fugitives were regularly crossing the property line). I contacted Mr. Riggs inside his

office and showed him the heavy emissions. He proceeded to immediately shut the furnace off and determine the problem with the baghouse. I again reminded Mr. Riggs of Regulation 34.0. An N.O.V. was not sent to S.M.S. due to Mr. Riggs lack of familiarity with the standard procedures and requirements required of him in dealing with air pollution issues.

6/22/89 Correspondence from S.M.S. Mr. Riggs contacted me by phone regarding the high stack emissions from #2 baghouse on 6/20/89. He explained that several of the bags were improperly installed and had come off the hangers.

6/29/89 Compliance inspection. B.R. and I made a compliance inspection to determine whether the corrective measures taken by S.M.S. would alleviate the visible emissions problem S.M.S. encountered on 1/23/89. I watched the smelting process while B.R. took V.E. readings. The facility conformed to K.C.A.P.C. Regulations and the corrective actions (A.P.C. 13) were approved.

8/1/89 Complaint (12:15 P.M.). (b) (6) contacted the Department concerning heavy fugitive emissions from S.M.S. She said the condition had going on throughout the morning.

8/1/89 Complaint (12:15 P.M.). (b) (6) contacted the Department concerning heavy fugitive emissions coming from S.M.S.. She reported that the emissions have been present throughout the morning and that the emissions burn her throat.

8/1/89 Complaint (4:00 P.M.). (b) (6) contacted the Department concerning heavy fugitive emissions coming from S.M.S.. She noted that the emissions were especially bad at night.

8/1/89 Complaint inspection. V.E.'s were taken on the fugitive emissions exiting the roof top. A six minute reading recorded an opacity of 85%. I then proceeded to the plant to investigate the problem. The fugitive emissions were not being pulled through the #2 capture hood, thus escaping around the edges. Inspection of the baghouse #2 showed seven separate vacuum breaches of the closed, negative pressure baghouse. These breaches were located at: 1) hopper panels, 2) inspection panels. 2) ducting. Mr. Riggs and Tommy Edmonds seemed unaware of a problem until I addressed it. I mentioned the possibility of the

vacuum breaches being part of the containment problem. However, I told them that the vacuum breaches may not be the only problem with the A.P.C. system, hence the breaches may not solve the problem with excessive fugitive emissions. They immediately shut the system down to determine the problem with the baghouse. (Department action pending)

8/4/89

Drop-by compliance inspection. B.R. and I went to S.M.S. to follow up on what the facility determined was the problem on 8/1/89 and to gather additional information concerning the non compliance episode of 8/1/89. Both furnaces were down and maintenance was being done to the #2 baghouse. Panels were being repaired to eliminate the vacuum breaches in the baghouse. Investigation of the plant site revealed melt materials that does not conform to 11/28/84 agreement made between K.C.D.A.P.C. and S.M.S. These materials were aluminum trim/siding. Approximately 90% of the material was painted and rubber trim was also observed in the same pile. Photos were taken on the inspection and are documented accordingly:

- #1 Smokey Mountain Smelters.
- #2 Vacuum breach on #2 baghouse hopper.
- #3 Vacuum breach on #1 baghouse hopper (it was not being repaired at that time).
- #4 Damage to #2 baghouse hopper.
- #5 Panel installed to replace damaged hopper bin panel on #2 baghouse.
- #6 Repaired and damaged hopper bins on #2 baghouse.
- #7 Inspection panel openings to be replaced.
*Note: Look closely above the second and third bag from the right near the bottom of the picture. These are holes in the baghouse floor.
- #8 Aluminum trim/siding next to east entrance near #1 furnace.
- #9 Aluminum trim/siding.

(Department action pending)

" Groundwater Pathway Secondary Target Population "

Maupin, B.H. (TDEC/DSF). 1997a. Estimation of the groundwater pathway
secondary target population. December 1997.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

ESTIMATION OF THE GROUNDWATER PATHWAY
SECONDARY TARGET POPULATION

The total area of Knox County is approximately 329,600 acres, or 515 square miles (USDA/SCS 1955).

The 1990 Census revealed that in the Knoxville Metropolitan Statistical Area there were 2.56 persons per occupied housing unit (USBC 1990).

The 1990 Census revealed that in Knox County, individual wells were the source of water for 6026 housing units (USBC 1990). This amounts to 15,400 persons, in the entire county, or, proportionally, approximately 1500 in the 4 miles radius, or 50.3 square miles, study area.

Proportioned by area, by distance category, the following target populations have been estimated:

0 to ¼ mile	6
¼ to ½ mile	17
½ to 1 mile	71
1 to 2 miles	281
2 to 3 miles	468
3 to 4 miles	657
0 to 4 miles	1500

" Hazardous Waste Quantity Calculation "

Maupin, B.H. (TDEC/DSF). 1997b. Hazardous waste quantity calculation.
December.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

HAZARDOUS WASTE QUANTITY CALCULATION

The waste quantity is estimated from observations of waste locations made during Site investigations made during October 1997 (which are depicted in the Site Sketch, Figure IV), by using a conservative minimum outside waste depth of two feet (which was noted during collection of Sample WA-04) and inside waste depth of one-half foot, and by using the property boundary lengths noted on the property map, Figure 3, and on the Ownership Cards in Appendix 1.

The outside waste area was estimated to be approximately 160,000 ft². The waste inside the building was estimated to cover approximately 7,500 ft². Total minimum volume was estimated to be 1,190 cubic yards, outside, and 139 cubic yards, inside.

**" Letters to Daniel E. Johnson (Property Owner),
RE: Site Entry "**

Maupin, B.H. (TDEC/DSF). 1997c. Letters to Daniel E. Johnson (Property Owner),
RE: Site Entry - Smokey Mountain Smelters. Tennessee Department of
Environment and Conservation/Division of Solid Waste Management.
September 9.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



FILE COPY

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

Daniel E. Johnson
P O Box 2704
Knoxville, TN 37901

CERTIFIED MAIL
Return Receipt Requested
P 286 042 086

RE: Smokey Mountain Smelters, Inc.
1508 Maryville Pike
Knox County
Site # 47-559

Dear Mr. Johnson:

The Tennessee Division of Superfund plans to conduct a Preliminary Assessment at the above referenced site. Records obtained from the Property Assessor's Office at the Knox County Courthouse indicate that you are the owner of the property located at 1508 Maryville Pike.

The Division requests your permission to enter the property on Monday, September 15, 1997. Your cooperation in this matter is appreciated.

Please contact me at 423/594-5479, as soon as possible, if there are any questions, or if I may provide additional information. Thank you.

Sincerely,

Burl H. Maupin
Burl H. Maupin

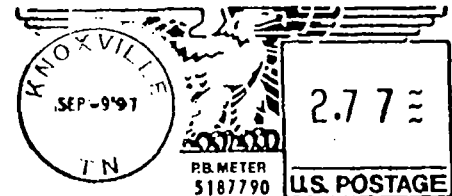
Division of Superfund

cc: DSF Central Office, Site # 47-559 file

CERTIFIED

P 286 042 086

MAIL



Mr. Daniel E. Johnson
P.O. Box 2704
Knoxville, Tennessee 37901

OCT 10 1997

9-10
9-17
2704

78-2704
37901

ATTEMPTED TO DELIVER
TO ADDRESSEE
RETURNED TO SENDER

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE SUITE 220
KNOXVILLE, TENNESSEE 37921-5602

37901-2704





STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602
(615) 594-6035 FAX (615) 594-6105

Daniel E. Johnson
912 S. Gay Street, Suite 1600
Knoxville, TN 37902

CERTIFIED MAIL
Return Receipt Requested
P 286 042 087

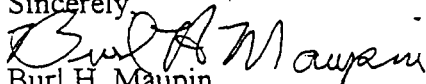
RE: Smokey Mountain Smelters, Inc.
1508 Maryville Pike
Knox County
Site # 47-559

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Sincerely,

Burl H. Maupin
Division of Superfund

cc: DSF Central Office, Site # 47-559 file

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KNOXVILLE ENVIRONMENTAL FIELD OFFICE
2700 MIDDLEBROOK PIKE, SUITE 220
KNOXVILLE, TENNESSEE 37921-5602



CERTIFIED

P 286 042 087

MAIL

Mr. Daniel E. Johnson
912 S. Gay Street, Suite 1600
Knoxville, Tennessee 37902

SEP 12 1997

FILE COPY

37302-1814 30

ns to conduct a Preliminary Assessment at the
om the Property Assessor's Office at the Knox
e the owner of the property located at 1508

enter the property on Monday, September 15,
preciated.

n as possible, if there are any questions, or if I
k you.



OF TENNESSEE
ONMENT AND CONSERVATION
ONMENTAL FIELD OFFICE
ROOK PIKE, SUITE 220
ENNESSEE 37921-5602
FAX (615) 594-6105

CERTIFIED MAIL
Return Receipt Requested
P 286 042 087



" Features Within A Four Miles Radius "

Maupin, B.H. (TDEC/DSF). 1997d. "Features within a four miles radius of Smokey Mountain Smelters". December.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

TABLE 1 - USGS GNIS Query Results, 7.5' x 7.5' Map: Knoxville
with CERCLA sites and TDEC/DWS 1997 wells added

**FEATURES NO MORE THAN ONE QUARTER
MILE DISTANT FROM THE SITE**

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
SMOKEY MOUNTAIN SMELTERS	Knox	Site	355509N	0835536W	0
Knox Fertilizer	Knox	well-ind	355512	835533	387.2127
(b) (6)	Knox	well-home	355509	835545	737.496
Kingsley Station	Knox	pop pl	355506N	0835547W	949.7333

**FEATURES BETWEEN ONE QUARTER AND
ONE HALF MILE DISTANT FROM THE SITE**

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Deadrick	Knox	well-home	355524	835524	1790.095
South Knoxville Optimist Park	Knox	park	355520N	0835514W	2110.273
(b) (6)	Knox	well-home	355518	835602	2311.865
Maxwell	Knox	well-home	355509	835506	2458.32

**FEATURES BETWEEN ONE HALF AND ONE
MILE DISTANT FROM THE SITE**

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Mountain View Church	Knox	church	355531N	0835515W	2788.254
Vestal School	Knox	school	355537N	0835538W	2797.022
(b) (6)	Knox	well-home	355440	835545	2984.494
Vestal	Knox	pop pl	355537N	0835520W	3084.715
(b) (6)	Knox	well-home	355533	835605	3372.711
(b) (6)	Knox	well	355522	835615	3448.747
(b) (6)	Knox	well	355521	835616	3489.372
Rodgers Ridge	Knox	ridge	355446N	0835458W	3867.406
Davis Cemetery	Knox	cemetery	355429N	0835515W	4344.237
(b) (6)	Knox	well-home	355425	835550	4535.263
Mount Olive Cemetery	Knox	cemetery	355430N	0835610W	4784.128
Easglor H L	Knox	well-home	355456	835438	4926.385
Immanuel Baptist Knoxville Church	Knox	church	355552N	0835459W	5251.659

FEATURES BETWEEN ONE AND TWO MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Chapman Ridge	Knox	ridge	355534N	0835633W	5294.501
Candors Mablee	Knox	well-ind	355557	835508	5308.154
Mount Olive	Knox	pop pl	355429N	0835621W	5432.189
Brown Cemetery	Knox	cemetery	355435N	0835440W	5705.566
Mount Olive Elementary School	Knox	school	355425N	0835625W	5947.671
(b) (6)	Knox	well-home	355449	835646	6072.924
	Knox	well-home	355449	835646	6072.924
Vestal United Methodist Church	Knox	church	355600N	0835451W	6281.966
(b) (6)	Knox	well-home	355408	835510	6445.356
Bethel Church (historical)	Knox	church	355415N	0835620W	6480.585
Bethel Cemetery	Knox	cemetery	355413N	0835617W	6517.169
(b) (6)	Knox	well-home	355442	835421	6709.723
(b) (6)	Knox	well-home	355425	835430	6964.356
(b) (6)	Knox	well	355358	835555	7249.425
(b) (6)	Knox	well-home	355426	835423	7360.069
(b) (6)	Knox	well-home	355404	835619	7377.745
Williams-Henson Boys Home	Knox	building	355404N	0835619W	7377.745
Mary Vestal Park	Knox	park	355615N	0835455W	7389.571
Mount Olive Baptist Church	Knox	church	355815N	0835421W	7493.877
Barber Hill	Knox	summit	355513N	0835709W	7631.224
Perdigo P	Knox	well-home	355420	835422	7787.621
Young High School	Knox	school	355600N	0835421W	7977.245
(b) (6)	Knox	well-home	355410	835430	7991.65
Mooreland Heights Elementary School	Knox	school	355507N	0835358W	8032.988
(b) (6)	Knox	well-home	355408	835430	8139.604
South Knoxville Post Office	Knox	post office	355604N	0835422W	8176.331
Wise Hill	Knox	summit	355539N	0835400W	8416.282
Looney Shoals	Knox	rapids	355545N	0835709W	8424.044
Dunford R E	Knox	well-home	355533	835715	8458.13
Spring Creek	Knox	stream	355532N	0835716W	8509.337
Flenniken Elementary School	Knox	school	355623N	0835444W	8521.316
Clark Home Builders	Knox	well-home	355343	835545	8607.744
Young High School Church of Christ	Knox	church	355553N	0835404W	8722.771
Third Creek	Knox	stream	355634N	0835607W	8848.83
University of Tennessee Hospital Airport	Knox	airport	355623N	0835636W	8867.317
Parkway Shopping Center	Knox	locale	355619N	0835429W	8880.921
Looney Islands	Knox	island	355544N	0835717W	8982.197
University Hospital	Knox	hospital	355626N	0835636W	9117.793
Ginn Cemetery	Knox	cemetery	355436N	0835720W	9135.481
Burleson Will	Knox	well-home	355500	835730	9384.631

TABLE 1 (continued)-USGS GNIS Query Results. 7.5'x7.5' Map: Knoxville, with TDEC/DWS 1997 wells added

FEATURES BETWEEN ONE AND TWO MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Woodlawn Cemetery	Knox	cemetery	355601N	0835400W	9421.976
Goose Creek	Knox	stream	355646N	0835522W	9740.826
Harris Chapel	Knox	church	355352N	0835422W	9784.23
(b) (6)	Knox	well-home	355403	835705	9823.758
K.M.C. Company	Knox	well-comm	355646	835606	9980.527
Woodlawn Christian Church	Knox	church	355615N	0835404W	10007.62
Harris Chapel Cemetery	Knox	cemetery	355350N	0835420W	10042.32
UT#2	Knox	well	355408	835714	10074.35
UT#1B	Knox	well	355409	835716	10146.34
I.C. King Park	Knox	park	355345N	0835646W	10152.38
UT#1C	Knox	well	355407	835715	10199.93
UT#1	Knox	well	355408	835716	10205.47
UT#1A	Knox	well	355408	835716	10205.47
UT#1D	Knox	well	355408	835716	10205.47
UT#2A	Knox	well	355408	835716	10205.47
UT#3	Knox	well	355408	835716	10205.47
UT#3A	Knox	well	355408	835716	10205.47
UT#3B	Knox	well	355408	835716	10205.47
UT#3D	Knox	well	355408	835716	10205.47
UT#3E	Knox	well	355408	835716	10205.47
UT#3F	Knox	well	355408	835716	10205.47
UT#3G	Knox	well	355408	835716	10205.47
UT#4	Knox	well	355408	835716	10205.47
UT#5	Knox	well	355408	835716	10205.47
UT#5A	Knox	well	355408	835716	10205.47
UT#6	Knox	well	355408	835716	10205.47
(b) (6)	Knox	well-home	355422	835727	10232.33
U T Department of Agriculture	Knox	school	355644N	0835624W	10257.67
UT#3C	Knox	well	355408	835717	10271.38
WSKT-AM (Knoxville)	Knox	tower	355442N	0835333W	10432.55
(b) (6)	Knox	well-home	355325	835518	10475.45
Graystone Presbyterian Church	Knox	church	355642N	0835436W	10496.82
Kerns Quarry	Knox	mine	355542N	0835334W	10524.87

TABLE 1 (continued)-USGS GNIS Query Results, 7.5'x7.5' Map:Knoxville, with TDEC/DWS 1997 wells added

FEATURES BETWEEN TWO AND THREE MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Fort Dickerson Park	Knox	park	355653N	0835457W	10852.31
Cherokee Bluffs	Knox	cliff	355527N	0835748W	10964.53
Mooreland Heights	Knox	pop pl	355459N	0835322W	11025.69
Fire Station Number 28	Knox	building	355328N	0835440W	11068.03
Flenniken Branch	Knox	stream	355343N	0835704W	11204.86
Clinch Avenue Park	Knox	park	355702N	0835550W	11326.83
McCarrell Spring	Knox	spring	355435N	0835749W	11413.77
James E Karnes Bridge	Knox	bridge	355649N	0835644W	11423.4
Stokely Athletic Center	Knox	building	355704N	0835547W	11503.4
Crenshaw	Knox	pop pl	355318N	0835616W	11544.25
Timberlake	Knox	pop pl	355443N	0835756W	11761.5
McClung Museum	Knox	building	355707N	0835538W	11768.34
Maxey Dock	Knox	locale	355414N	0835744W	11836.28
Welwyn (historical)	Knox	pop pl	355340N	0835712W	11859.76
South Knoxville	Knox	pop pl	355635N	0835356W	11861.6
McCarrell Cemetery	Knox	cemetery	355426N	0835752W	11940.88
WUTK-FM (Knoxville)	Knox	tower	355709N	0835534W	11967.76
(b) (6)	Knox	well-home	355357	835339	11977.95
Southbrook	Knox	pop pl	355445N	0835312W	12040.2
Robertshaw-Fulton C	Knox	well-ind	355703	835627	12112.13
Robertshaw-Fulton C	Knox	well-other	355703	835627	12112.13
(b) (6)	Knox	well-home	355531	835310	12163.31
South Knoxville Quarry	Knox	mine	355705N	0835448W	12218.18
(b) (6)	Knox	well-home	355350	835341	12282.79
South Young High School	Knox	school	355623N	0835335W	12359.92
Sequoyah Hills Presbyterian Church	Knox	church	355602N	0835753W	12408.24
Screen Art Inc.	Knox	CERCLA	355648	835354	12935.49
Witherspoon Landfill	Knox	CERCLA	355648	835254	12935.49
Witherspoon, David Incorporated	Knox	CERCLA	355648	835354	12935.49
Shields-Wakins Field	Knox	park	355717N	0835529W	12777.3
(b) (6)	Knox	well-home	355305	835618	12835.55
Hodges Library	Knox	building	355718N	0835548W	12901.67
Colonial Village	Knox	pop pl	355510N	0835258W	12947.54
East Tennessee Baptist Hospital	Knox	hospital	355715N	0835454W	13027.8
Sequoyah Park	Knox	park	355539N	0835812W	13128.67
Tyson Junior High School	Knox	school	355709N	0835644W	13200.37
Fifth Avenue Baptist Church	Knox	church	355908N	0835349W	13353.71
(b) (6)	Knox	well-home	355453	835818	13370.47
Lake Hills Church	Knox	church	355446N	0835817W	13390.87
Chapman Highway Shopping Center	Knox	locale	355518N	0835252W	13468.75
Sevier Heights Baptist Church	Knox	church	355632N	0835325W	13555.09
(b) (6)	Knox	well-home	355304	835431	13555.54
(b) (6)	Knox	well-home	355420	835300	13685.34

TABLE 1 (continued)-USGS GNIS Query Results, 7.5'x7.5' Map:Knoxville, with TDEC/DWS 1997 wells added

FEATURES BETWEEN TWO AND THREE MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Tyson Park	Knox	park	355715N	0835643W	13712.09
Henley Street Bridge	Knox	bridge	355724N	0835504W	13715.47
Calvary Baptist Church	Knox	church	355707N	0835702W	13716.04
Williams Shoals	Knox	bar	355338N	0835743W	13807.73
Fort Sanders School	Knox	hospital	355725N	0835614W	13915.07
First United Methodist Church	Knox	church	355658N	0835724W	14016.85
Rock City Park	Knox	park	355700N	0835351W	14019.87
Tennessee Valley Unitarian Church	Knox	church	355705N	0835713W	14035.41
First Church of Christ Science	Knox	church	355655N	0835729W	14052.67
East Tennessee Childrens Hospital	Knox	hospital	355726N	0835612W	14088.75
Williams Island (historical)	Knox	island	355340N	0835751W	14182.66
Henson Spring Branch	Knox	stream	355358N	0835807W	14256.04
Hoskins Library	Knox	building	355732N	0835541W	14266.13
South Knox Elementary School	Knox	school	355724N	0835438W	14276.79
Southside Church	Knox	church	355333N	0835326W	14322.32
East Third Creek	Knox	stream	355718N	0835653W	14328.23
Church Street United Methodist Church	Knox	church	355733N	0835515W	14462.71
Knob Creek	Knox	stream	355319N	0835732W	14514.92
WIMZ-AM (Knoxville)	Knox	tower	355717N	0835704W	14660.49
Jones Cove	Knox	valley	355425N	0835827W	14683.34
Fort Sanders Baptist Church	Knox	church	355735N	0835602W	14714.47
Simpson School	Knox	school	355253N	0835647W	14757.45
New Salem Church	Knox	church	355307N	0835354W	14760.58
DeArmond Spring	Knox	spring	355258N	0835700W	14766.07
Atlantic Co	Knox	well	355737	835530	14767.04
Humes Ferry (historical)	Knox	crossing	355732N	0835447W	14814.75
First Baptist Church of Knoxville	Knox	church	355736N	0835505W	14877.61
Hillcrest United Methodist Church	Knox	church	355701N	0835335W	14935.03
Knoxville	Knox	pop pl	355738N	0835515W	14957.89
Bicentennial Park	Knox	park	355736N	0835449W	15156.62
DeArmond Spring Branch	Knox	stream	355303N	0835720W	15182.42
(b) (6)	Knox	pop pl	355300N	0835359W	15291.73
Bonny Kate Elementary School		school	355258N	0835355W	15296.53
East Tennessee Packing C	Knox	well-ind	355733	835431	15315.97
East Tennessee Packing C	Knox	well-ind	355733	835431	15315.97
East Tennessee Packing C	Knox	well-ind	355733	835431	15315.97
First Creek	Knox	stream	355737N	0835446W	15317.01
Knox County Courthouse	Knox	building	355740N	0835500W	15344.26
Stanles Knitting Mi	Knox	well	355743	835521	15406.3
Wells Cemetery	Knox	cemetery	355526N	0835843W	15417.02
Sequoyah Hills	Knox	pop pl	355610N	0835829W	15426.32
Knoxville City Expo Site	Knox	well	355744	835525	15483.17
Saint Johns Episcopal Church	Knox	church	355743N	0835507W	15539.96
Kingston Pike Shopping Center	Knox	locale	355626N	0835821W	15549.01
Gray Marble Co	Knox	well-ind	355732	835652	15560.83
Bartletts Fort (historical)	Blount	locale	355233N	0835647W	15678.84
Lyons Island	Knox	island	355455N	0835847W	15713.45
Emmanuel United Presbyterian Church	Knox	church	355920N	0835253W	15766.24

TABLE 1 (continued)-USGS GNIS Query Results, 7.5'x7.5' Map:Knoxville, with TDEC/DWS 1997 wells added

FEATURES BETWEEN THREE AND FOUR MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Tipton Cemetery	Blount	cemetery	355231N	0835649W	15925.05
Lyons Shoals	Knox	bar	355450N	0835850W	16009.65
Conergy Market World Fair Site	Knox	well	355750	835535	16055.45
Stock Creek	Knox	stream	355231N	0835654W	16083.43
Lakemoor Hills	Knox	pop pl	355538N	0835850W	16158.04
Marble City Baptist Church	Knox	church	355713N	0835743W	16161.98
Dixie Laundry Compa	Knox	well-ind	355740	835421	16263.91
Doyle Middle School	Knox	school	355323N	0835305W	16273.93
University of Tennessee Experimental Farm	Knox	locale	355733N	0835710W	16295.42
Twin Creek	Knox	stream	355237N	0835356W	16360.58
Marble City	Knox	pop pl	355709N	0835753W	16408.26
Hotel Farragut	Knox	well-ind	355752	835505	16451.98
First Presbyterian Church	Knox	church	355751N	0835458W	16452.33
Hillvale Country Club	Knox	locale	355237N	0835719W	16485.08
Knoxville City Hall	Knox	building	355755N	0835524W	16583.03
Market Square	Knox	park	355755N	0835511W	16680.13
Fire Station Number 17	Knox	building	355417N	0835851W	16799.43
Doyle High School	Knox	school	355315N	0835305W	16803.07
Rudder Cemetery	Knox	cemetery	355412N	0835849W	16805.65
Interchange 386	Knox	crossing	355748N	0835645W	16833.76
Riverbend	Knox	pop pl	355343N	0835835W	16991.14
Summit Hill	Knox	summit	355759N	0835521W	16997.24
Peter Blow Bend	Knox	bend	355549N	0835858W	17026.53
Marble Springs	Knox	locale	355348N	0835233W	17032.86
(b) (6)	Knox	well-home	355452	835903	17046.91
Knoxville Civic Auditorium	Knox	building	355754N	0835441W	17060.21
Flint Hill	Knox	summit	355752N	0835431W	17105.11
Western Plaza Shopping Center	Knox	locale	355630N	0835841W	17177.32
Immaculate Conception Catholic Church	Knox	church	355801N	0835519W	17208.66
Cal Johnson Park	Knox	park	355800N	0835458W	17334.44
(b) (6)	Knox	well-home	355307	835808	17411.28
Old Water Mill	Knox	locale	355423N	0835901W	17413.58
McMillan School (historical)	Knox	school	355758N	0835440W	17466.59
Topside	Knox	pop pl	355233N	0835735W	17523.27
(b) (6)	Knox	well-home	355725	835320	17553.64
Mark James Park	Knox	park	355715N	0835306W	17577.31
Knott Cemetery	Knox	cemetery	355717N	0835804W	17607.15
Mount Pleasant Church	Knox	church	355608N	0835859W	17644.48
John Tarleton Institute	Knox	school	355727N	0835751W	17656.73
Coatney Hollow	Knox	valley	355253N	0835318W	17658.14
Interchange 387	Knox	crossing	355806N	0835545W	17666.19
Deaderick Avenue Baptist Church	Knox	church	355805N	0835603W	17689.98
Lyons View School (historical)	Knox	school	355608N	0835900W	17721.76

TABLE 1 (continued)-USGS GNIS Query Results, 7.5'x7.5' Map:Knoxville, with TDEC/DWS 1997 wells added

FEATURES BETWEEN THREE AND FOUR MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Mockingbird Hill	Knox	pop pl	355401N	0835857W	17812.04
Leslie Street Park	Knox	park	355757N	0835654W	17931.14
Lyons Bend	Knox	bend	355305N	0835815W	17962.84
Island Home	Knox	pop pl	355721N	0835305W	18065.91
Knoxville Division	Knox	civil	355805N	0835633W	18161.95
Cherokee Golf and Country Club	Knox	locale	355600N	0835909W	18179.94
Maynard Elementary School	Knox	school	355808N	0835619W	18194.69
Washburn Street Church	Knox	church	355703N	0835831W	18299.72
Southern Station	Knox	locale	355812N	0835513W	18346.19
Baker Creek	Knox	stream	355736N	0835321W	18364.85
Temperance Hill	Knox	summit	355808N	0835442W	18390.52
WKGK-AM (Knoxville)	Knox	tower	355720N	0835814W	18392.55
Green Elementary School	Knox	school	355808N	0835440W	18430.64
Lakeshore Mental Health Institute	Knox	hospital	355528N	0835921W	18534.5
Knoxville College	Knox	school	355811N	0835631W	18700.62
Mount Olive Baptist Church	Knox	church	355426N	0835619W	18880.01
Beardsley Middle School	Knox	school	355808N	0835653W	18932.6
Williams Creek	Knox	stream	355746N	0835326W	18936.79
Causier School	Knox	school	355810N	0835646W	18939.21
Morningside Park	Knox	park	355807N	0835415W	18950.9
(b) (6)	Knox	well-home	355403	835913	18960.81
Island Home Baptist Church	Knox	church	355721N	0835247W	19106.4
Wallace Chapel African Methodist Episcopal Zion	Knox	church	355617N	0835914W	19107.55
Knox Plaza Shopping Center	Knox	locale	355623N	0835912W	19176.61
Interchange 385	Knox	crossing	355728N	0835818W	19192.73
Westminister Ridge	Knox	pop pl	355434N	0835927W	19248.15
Maynard Glen Park	Knox	park	355717N	0835240W	19259.51
Lyons View	Knox	pop pl	355539N	0835929W	19325.91
First Christian Church	Knox	church	355823N	0835522W	19380.05
Victory Temple Assembly of God Church	Knox	church	355824N	0835528W	19456.84
Old Gray Cemetery	Knox	cemetery	355825N	0835529W	19553.93
Forest Hills	Knox	pop pl	355633N	0835912W	19582
Saint Johns Lutheran Church	Knox	church	355826N	0835525W	19665.9
West View United Methodist Church	Knox	church	355743N	0835806W	19670.45
Belmont Heights Baptist Church	Knox	church	355806N	0835723W	19708.59
Baker Shoals	Knox	bar	355745N	0835308W	19725.37
Taylor George P	Knox	well-home	355458	835937	19778.95
Vine Junior High School	Knox	school	355820N	0835421W	20013.88
Central Church of God	Knox	church	355717N	0835845W	20069.64
Malcom Martin Park	Knox	park	355822N	0835647W	20106.5
Tennessee for Deaf School	Knox	school	355730N	0835240W	20142.1
National Cemetery	Knox	cemetery	355831N	0835536W	20143.84
Village Square Shopping Center	Knox	locale	355614N	0835929W	20163.24

TABLE 1 (continued)-USGS GNIS Query Results, 7.5'x7.5' Map:Knoxville, with TDEC/DWS 1997 wells added

FEATURES BETWEEN THREE AND FOUR MILES DISTANT FROM THE SITE

Feature Name	County	Type	Latitude	Longitude	Distance (feet)
Interchange 388	Knox	crossing	355830N	0835507W	20184.5
Lyons Mill (historical)	Knox	locale	355501N	0835944W	20337.76
Westminister Presbyterian Church	Knox	church	355457N	0835944W	20357.31
Pond Gap Elementary School	Knox	school	355706N	0835900W	20385.63
Beaumont Avenue Baptist Church	Knox	church	355826N	0835644W	20420.2
Mount Calvary Baptist Church	Knox	church	355820N	0835406W	20424.85
Mountain View School (historical)	Knox	school	355821N	0835404W	20577.35
Crestview Cemetery	Knox	cemetery	355801N	0835755W	20589.67
McMullen Quarry	Knox	mine	355756N	0835308W	20601.53
Mabrys Hill	Knox	summit	355822N	0835404W	20670.17
Central United Methodist Church	Knox	church	355836N	0835521W	20679.02
Bearden United Methodist Church	Knox	church	355616N	0835935W	20692.94
Marble Hill	Knox	summit	355753N	0835301W	20707.25
Beaumont Elementary School	Knox	school	355833N	0835628W	20784.76
Austin High School	Knox	school	355827N	0835416W	20804.76
Schriver W	Knox	well	355357	835936	20936.23
Knox County Health Center	Knox	hospital	355839N	0835538W	20942.26
Virginia Avenue United Methodist Church	Knox	church	355823N	0835716W	21009.96
Badgett Drive Ldfl	Knox	CERCLA	355630	835906	21017.15
Church of the Ascension	Knox	church	355532N	0835951W	21021.22
Highland Memorial Cemetery	Knox	cemetery	355632N	0835932W	21035.59
Duncan Dock	Knox	locale	355317N	0835914W	21067.95
(b) (6)	Knox	well-home	355322	835918	21089.98

TABLE 1 (continued)-USGS GNIS Query Results, 7.5'x7.5' Map:Knoxville, with TDEC/DWS 1997 wells added

TABLE TWO

SCHOOLS NEAR THE SMOKEY MOUNTAIN SMELTER SITE

Vestal School (closed)	Knox	school	355537N	0835538W	2797.022
Mount Olive Elementary School	Knox	school	355425N	0835625W	5947.671
Young High School (closed)	Knox	school	355600N	0835421W	7977.245
Mooreland Heights Elementary School	Knox	school	355507N	0835358W	8032.988
Flenniken Elementary School (closed)	Knox	school	355623N	0835444W	8521.316
U T Department of Agriculture	Knox	school	355644N	0835624W	10257.67
Doyle Middle School (formerly South Young High School)	Knox	school	355623N	0835335W	12359.92
University of Tennessee	Knox	school	355715N	0835551W	12624.95
Dogwood Elementary School (formerly South Young High School)	Knox	school	355647N	0835356W	12753.63
Tyson Junior High School (closed)	Knox	school	355709N	0835644W	13200.37
South Knox Elementary School	Knox	school	355724N	0835438W	14276.79
Simpson School (closed)	Knox	school	355253N	0835647W	14757.45
Bonny Kate Elementary School	Knox	school	355258N	0835355W	15296.53
South Doyle Middle School (formerly Doyle Middle School)	Knox	school	355323N	0835305W	16273.93
South Doyle High School (formerly Doyle High School)	Knox	school	355315N	0835305W	16803.07
McMillan School (historical)	Knox	school	355758N	0835440W	17466.59
John Tarleton Institute (orphanage)	Knox	school	355727N	0835751W	17656.73
Lyons View School (historical)	Knox	school	355608N	0835900W	17721.76
Maynard Elementary School	Knox	school	355808N	0835619W	18194.69
Green Elementary School	Knox	school	355808N	0835440W	18430.64
Knoxville College	Knox	school	355811N	0835631W	18700.62
Beardsley Middle School (closed)	Knox	school	355808N	0835653W	18932.6
Causier School (?)	Knox	school	355810N	0835646W	18939.21
Vine Middle School (formerly Vine Junior High School)	Knox	school	355820N	0835421W	20013.88
Tennessee for Deaf School	Knox	school	355730N	0835240W	20142.1
Pond Gap Elementary School	Knox	school	355706N	0835900W	20385.63
Mountain View School (historical)	Knox	school	355821N	0835404W	20577.35
Beaumont Elementary School	Knox	school	355833N	0835628W	20784.76
Vine Middle School (formerly Austin High School)	Knox	school	355827N	0835416W	20804.76
Rule High School (closed)	Knox	school	355829N	0835712W	21439.75
Bearden Middle School	Knox	school	355608N	0835950W	21629.38
Knoxville Catholic High School (closed)	Knox	school	355842N	0835428W	21959.52
Bearden Elementary School	Knox	school	355606N	0835955W	21971.49
Eastport Elementary School (closed)	Knox	school	355831N	0835348W	22002.18
Creswell School (historical)	Knox	school	UNKNOWN	UNKNOWN	UNKNOWN
East Tennessee Female Institute (historical)	Knox	school	UNKNOWN	UNKNOWN	UNKNOWN
Hampden Sidney Academy (historical)	Knox	school	UNKNOWN	UNKNOWN	UNKNOWN
Knoxville Female Academy (historical)	Knox	school	UNKNOWN	UNKNOWN	UNKNOWN
Knoxville Literary Presbyterian Church (?)	Knox	school	UNKNOWN	UNKNOWN	UNKNOWN
Slater Training Academy and Industrial	Knox	school	UNKNOWN	UNKNOWN	UNKNOWN

updated 12-97 according to information provided by Ms. Sharon Jenkins, Knox County School System

" Home and unspecified-use wells "

Maupin, B.H. (TDEC/DSF). 1997e. "Home and unspecified-use wells within a four miles radius of Smokey Mountain Smelters". December.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

**TABLE ONE - HOME AND UNSPECIFIED-USE WELLS NEAR
SMOKEY MOUNTAIN SMELTERS**

Owner's name	Co	Use	Latitude	Longitude	Distance (feet)
(b) (6)	Knox	home	355509	835545	737.496
(b) (6)	Knox	home	355524	835524	1790.095
	Knox	home	355518	835602	2311.865
Maxwell	Knox	home	355509	835506	2458.32
(b) (6)	Knox	home	355440	835545	2984.494
	Knox	home	355533	835605	3372.711
(b) (6)	Knox	home	355425	835550	4535.263
	Knox	home	355456	835438	4926.385
Elliot Bill	Knox	home	355449	835646	6072.924
(b) (6)	Knox	home	355449	835646	6072.924
	Knox	home	355408	835510	6445.356
	Knox	home	355442	835421	6709.723
	Knox	home	355425	835430	6964.356
	Knox	home	355426	835423	7360.069
Neas Mark	Knox	home	355404	835619	7377.745
(b) (6)	Knox	home	355420	835422	7787.621
	Knox	home	355410	835430	7991.65
	Knox	home	355408	835430	8139.604
	Knox	home	355533	835715	8458.13
Clark Home Builders	Knox	home	355343	835545	8607.744
Burleson Will	Knox	home	355500	835730	9384.631
(b) (6)	Knox	home	355403	835705	9823.758
	Knox	home	355422	835727	10232.33
Keener III Sam	Knox	home	355325	835518	10475.45
(b) (6)	Knox	home	355357	835339	11977.95
	Knox	home	355531	835310	12163.31
	Knox	home	355350	835341	12282.79
Harrison Wallace	Knox	home	355305	835618	12835.55
(b) (6)	Knox	home	355453	835818	13370.47
	Knox	home	355304	835431	13555.54
	Knox	home	355420	835300	13685.34
Atlantic Co	Knox	home	355737	835530	14767.04
(b) (6)	Knox	home	355452	835903	17046.91
	Knox	home	355307	835808	17411.28
	Knox	home	355725	835320	17553.64
	Knox	home	355403	835913	18960.81
	Knox	home	355458	835937	19778.95
	Knox	home	355322	835918	21089.98
	Knox	home	355727	835902	21779.18
Morris Robe	Knox	home	355337	835952	22896.12
(b) (6)	Knox		355522	835615	3448.747
Becker S.E.	Knox		355521	835616	3489.372
(b) (6)	Knox		355358	835555	7249.425
UT#2	Knox		355408	835714	10074.35
UT#1B	Knox		355409	835716	10146.34
UT#1C	Knox		355407	835715	10199.93
UT#1	Knox		355408	835716	10205.47
UT#1A	Knox		355408	835716	10205.47
UT#1D	Knox		355408	835716	10205.47
UT#2A	Knox		355408	835716	10205.47
UT#3	Knox		355408	835716	10205.47
UT#3A	Knox		355408	835716	10205.47
UT#3B	Knox		355408	835716	10205.47
UT#3D	Knox		355408	835716	10205.47
UT#3E	Knox		355408	835716	10205.47
UT#3F	Knox		355408	835716	10205.47
UT#3G	Knox		355408	835716	10205.47
UT#4	Knox		355408	835716	10205.47
UT#5	Knox		355408	835716	10205.47
UT#5A	Knox		355408	835716	10205.47
UT#6	Knox		355408	835716	10205.47
UT#3C	Knox		355408	835717	10271.38
(b) (6)	Knox		355357	835936	20936.23


Data from TDEC/DWS 1997.

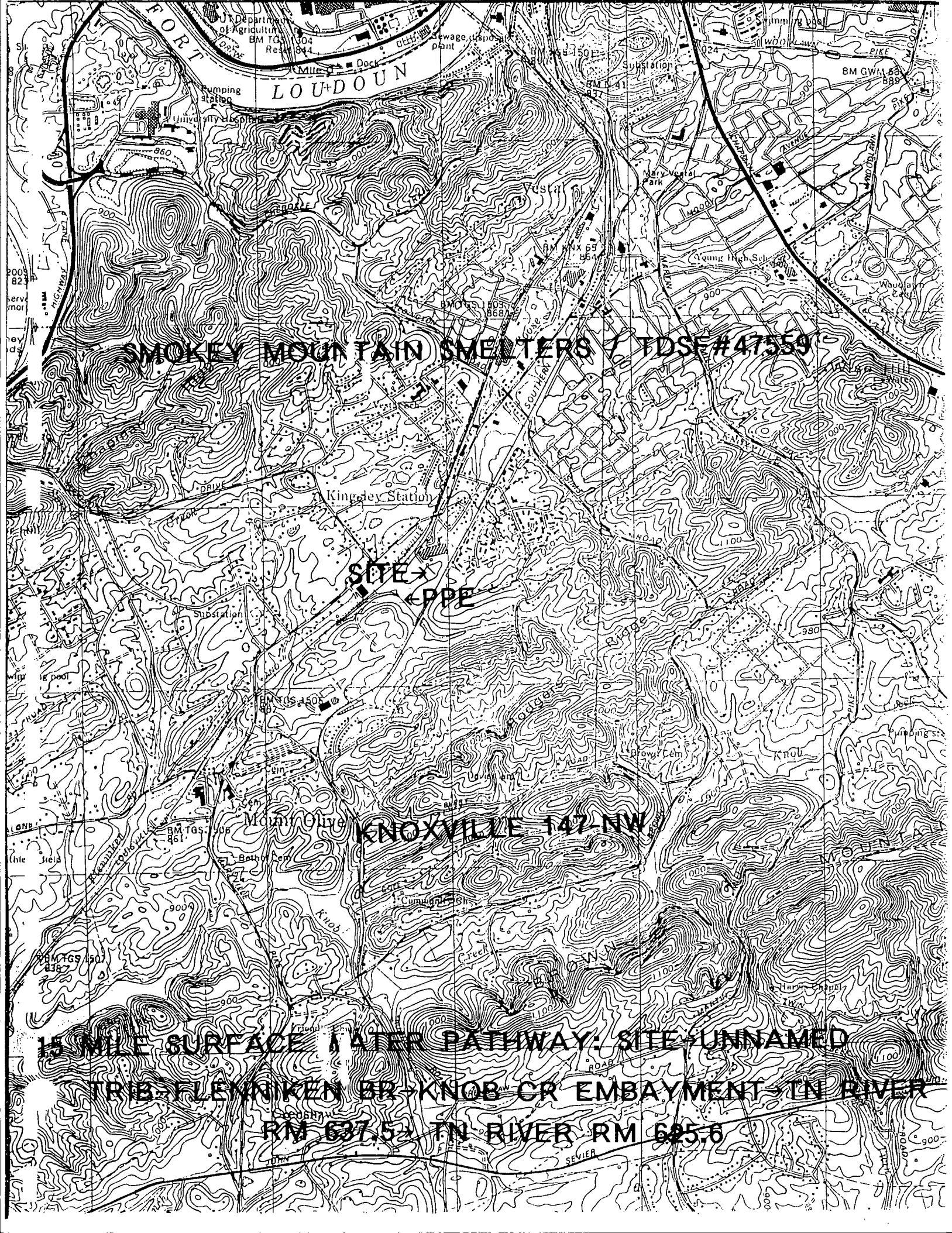
" Site Identification ("Discovery") "

Maupin, B.H. (TDEC/DSF). 1997f. Potential Hazardous Waste Site - Site Identification ("Discovery") August 6.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

FILE COPY

	POTENTIAL HAZARDOUS WASTE SITE SITE IDENTIFICATION ("DISCOVERY")				I. IDENTIFICATION	
	01 ST TN		02 SITE NUMBER TDSF#47-559 TND098071061			
II. SITE NAME AND LOCATION						
01 SITE NAME (Legal, common, or descriptive name of site) SMOKEY MOUNTAIN SMELTERS			02 STREET, ROUTE NUMBER, OR SPECIFIC LOCATION IDENTIFIER 1508 MARYVILLE PIKE			
03 CITY KNOXVILLE			04 ST TN	05 ZIP CODE 37920	06 COUNTY KNOX	07 CO CODE 47
08 CONG DIST 2						
09 DIRECTIONS TO SITE (Starting from nearest public road; enter up to 4 lines of text) The Site is easily visible and accessible from Maryville Pike, State Secondary Route #33, just outside the Knoxville City limits. From southbound Route #33, turn left onto Caleb Avenue before crossing a bridge over railroad tracks; the entrance to the Site is immediately on the right, at Caleb Avenue. LATITUDE: 35° 55' 09" LONGITUDE: 83° 55' 36" PPE at mile 1.2 of unnamed tributary of Flenniken Branch at mile 0.4.						
III. RESPONSIBLE PARTIES						
01 OWNER (If known) Daniel E. Johnson			02 STREET (Business, residential, mailing) P O Box 2704			
03 CITY Knoxville			04 ST TN	05 ZIP CODE 37901	06 TELEPHONE NUMBER	
07 OWNER (additional address) Daniel E. Johnson			08 STREET (Business, residential, mailing) 912 S. Gay Street, Suite 1600			
09 CITY Knoxville			10 ST TN	11 ZIP CODE 37902	12 TELEPHONE NUMBER	
13 TYPE OF OWNERSHIP (Mark one; use "insert" mode) <input checked="" type="checkbox"/> A. PRIVATE <input type="checkbox"/> B. FEDERAL (Agency name): _____ <input type="checkbox"/> C. STATE <input type="checkbox"/> D. COUNTY <input type="checkbox"/> E. MUNICIPAL <input type="checkbox"/> F. OTHER (Specify): _____ <input type="checkbox"/> G. UNKNOWN						
IV. HOW IDENTIFIED						
01 DATE IDENTIFIED June 25, 1995 <small>(Month/Day/Year)</small>		02 IDENTIFIED BY (Mark all that apply; use "insert" mode) <input type="checkbox"/> A. CITIZEN COMPLAINT <input type="checkbox"/> B. INDUSTRY <input checked="" type="checkbox"/> C. STATE/LOCAL GOVERNMENT <input type="checkbox"/> D. AERIAL RECONNAISSANCE <input type="checkbox"/> E. RCRA INSPECTION <input type="checkbox"/> F. SURFACE IMPOUNDMENT ASSESSMENT <input type="checkbox"/> G. OTHER EPA IDENTIFICATION <input checked="" type="checkbox"/> H. OTHER (Specify): <u>landfill shown on property map</u>				
V. SITE CHARACTERIZATION						
01 TYPE OF SITE (Mark all that apply; use "insert" mode) <input type="checkbox"/> A. STORAGE <input type="checkbox"/> B. TREATMENT <input checked="" type="checkbox"/> C. DISPOSAL <input checked="" type="checkbox"/> D. UNAUTHORIZED DUMPING <input type="checkbox"/> E. OTHER (Specify): _____						
02 SUMMARY OF KNOWN PROBLEMS (Provide narrative description; enter up to 6 lines of text) An unpermitted industrial landfill exists at this facility.						
03 SUMMARY OF ALLEGED OR POTENTIAL PROBLEMS (Provide narrative description; enter up to 5 lines of text) Unknown wastes and containment.						
VI. INFORMATION AVAILABLE FROM						
01 CONTACT Burl H. Maupin		02 OF (Agency/Organization) TDSF TDEC			03 TELEPHONE NUMBER 423/594-5479	
04 PREPARED BY Burl H. Maupin		05 AGENCY TDSF		06 ORGANIZATION TDEC		07 TELEPHONE NUMBER 423/594-5479
08 DATE (Month/Day/Year) August 6, 1997						



SMOKEY MOUNTAIN SMELTERS / IDSE #47559

SITE X
PPE

KNOXVILLE 142 NW

15 MILE SURFACE WATER PATHWAY: SITE UNNAMED
TRIBUTENNIKEN BR-KNOB CR EMBAYMENT-TN RIVER
RM 637.5 TN RIVER RM 625.6

" Wellhead Protection Areas "

Maupin, B.H. 1997g. "WHPA near SMS", memo to Files (DSF), dated November 21.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

MEMORANDUM

DATE: December 21, 1997
TO: Files
FROM: BHM
RE: WHPA near SMS

The absence of WHPA's within a four mile radius of Smokey Mountain Smelters was recently discussed with Mr. Steve Roberts, Knoxville Field Office Manager of the Division of Water Supply. The nearest WHPA is beyond RM 633 of the Tennessee River, which is at least five miles distant from the Site.

" Study Plan-Site Screening Investigation "

Maupin, B.H. 1998. "Study Plan-Site Screening Investigation". Tennessee Department of Environment and Conservation, Division of Superfund, August 21.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

STUDY PLAN
SITE SCREENING INVESTIGATION

SITE NAME: Smokey Mountain Smelters

SITE LOCATION: Knox County, Tennessee

U.S. EPA ID # TND098071061

TDSF SITE ID # 47-559

Prepared by the
TENNESSEE DIVISION OF SUPERFUND
in cooperation with
WASTE MANAGEMENT DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY

DATE: August 21, 1998

Prepared By: Burl H. Maupin

Reviewed By: _____

Approved By: _____

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STUDY PLAN
SITE SCREENING INVESTIGATION

SITE NAME: Smokey Mountain Smelters

LOCATION: Knox County, Tennessee
35°55'09" North Latitude
83°55'36" West Longitude

U.S. EPA ID # TND098071061

TDSF # 47-559

1.0 INTRODUCTION

The Tennessee Division of Superfund has been tasked by the U.S. Environmental Protection Agency (U.S. EPA), Waste Management Division to conduct a Site Investigation (SI) at the above referenced site. This investigation will be conducted pursuant to the authority and requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), Public Law 195-510; Section 104; and the Superfund Amendments and Reauthorization Act (SARA) of 1986, Public Law 99-499.

1.1 Objectives

The objectives of this sampling investigation are to collect information on the presence of any contaminants at the site, and to assist in developing a site-specific preliminary HRS score to determine if the site warrants inclusion on the National Priorities List (NPL).

Specific elements of the objectives include the following:

- Characterize the history, location, and nature of past hazardous materials management and disposal activities at the site
- Collect data on the levels and extent of the contaminants present at and near the site
- Obtain information to prepare a preliminary HRS score, including potential receptors impacted by any contamination migrating from the site
- Provide EPA the necessary information to make decisions on any other action warranted at the site

1.2 Scope of Work

The scope of this investigation will include, but is not necessarily limited to, the following activities:

- Obtain and review background materials relevant to HRS scoring of site
- Obtain available maps of the site
- Obtain information on local water systems

- Evaluate the target population within a 4 mile radius of the site with regard to surface water use, the possibility of direct contact, ground water use, fire and explosion hazard, and airborne exposure
- Develop a detailed site sketch
- Collect environmental samples consisting of groundwater, sediment, soil, surface water, and waste samples. The purpose of these samples is to attempt to detect the presence of any hazardous substances at the site, to identify source area(s) for contaminants, to identify chemicals of concern, and to estimate the extent of the contamination.

1.3 Schedule

Sample collection will be scheduled once this Study Plan has been submitted to the U.S. EPA. It is anticipated that sampling activities will take place in August 1998. Field sampling activities are expected to require two to three days to complete.

1.4 Personnel

The following TDSF personnel are scheduled to perform sampling activities at the Smokey Mountain Smelters Site:

Chris A. Andel - Geologist
 W. Lee Barron - Geologist
 Adam DeWeese - Environmental Specialist
 Burl H. Maupin - Environmental Protection Specialist/Project Manager
 Beth H. Walker - Environmental Specialist

1.5 Permits and Authorization Requirements

Agency/Party

Permit/Authorization

TDSF

Property Access - self authorized, if owner cannot be located

Any additional property access requirements will be identified and addressed as needed.

1.6 Site History and Description

1.61 Location

The Smokey Mountain Smelters, Knoxville, Site is an inactive secondary aluminum smelter located within Knox County, Tennessee, on Maryville Pike, State Secondary Route 33 (Vicinity Map, Figure 1), slightly beyond the city limits of Knoxville. The geographic coordinates of this facility are 35 degrees, 55 minutes, and 9 seconds North Latitude, and 83 degrees, 55 minutes, and 36 seconds West Longitude. The immediate area surrounding the facility is medium commercial and dense residential development. The property location, 1508 Maryville Pike, is that listed for the largest parcel, upon which the process building lies. Historically, SMS's location has been referred to as 1455 Maryville Pike. The 1455 street number was submitted by Mr. Johnson to the Knox County Department of Air Pollution Control (KCDAPC) on a permit application, and the facility's address was usually referred to as 1455 Maryville Pike, thereafter.

1.62 Facility Description

The Smokey Mountain Smelters Site, as observed during October 1997, consists of one large industrial process building (constructed in 1928) and several smaller outlying buildings, located on five parcels of real estate. The

property totals approximately 13 acres. The largest building is approximately 100 feet wide, 300 feet long, and 50 feet high. It houses two natural gas fired rotary furnaces, one casting furnace, a large overhead crane, and provides dry storage for process raw materials. Large air ducts lead to two small outside baghouses near the southwest corner of the building. A portion of the north wall of the building has collapsed. Features outlying the main building include a small transformer area to the north, a burned office building or house across a paved driveway with truck scales farther to the north, a concrete building foundation to the northeast, two curious jumbled concrete slabs farther to the northeast, Site railroad tracks to the east, a pump house at concrete supports for a missing horizontal tank near a 25 feet by 100 feet lagoon holding water to the southeast, a maintenance building to the south, and large continuous gray-colored waste piles covering most of the remaining property to the south. These features are shown in Figure 2, Site Sketch/Proposed Sample Locations.

Some evidence indicates that the facility may have engaged in primary production of aluminum.

1.63 Operational History

In September 1979, David A. Witherspoon, Jr. and Daniel E. Johnson purchased several tracts of property from Jerry V. Sternberg. The deed for this transaction indicates part of the property was owned by American Agricultural Company. An on-site or nearby industrial well is named for Knoxville Fertilizer Company. It is believed the property operated prior to 1979 as an agricultural or fertilizer business.

Smokey Mountain Smelters, a.k.a. Rotary Furnace, Inc., of 1455 [SIC] Maryville Pike, was established in 1979. The Standard Industrial Classification for secondary smelting and refining of nonferrous metals is 3341. Included in this industry are establishments primarily engaged in recovering nonferrous metals and alloys from new and used scrap and dross or in producing alloys from purchased refined metals. This industry includes establishments engaged in both the recovery and alloying of precious metals. Plants engaged in the recovery of tin through secondary smelting and refining, as well as by chemical processes, are included in this industry.

Large blocks of materials, stored inside the building, resemble spent anode or cathode materials from primary aluminum production. Such materials might contain recoverable aluminum.

Raw materials included aluminum dross; the product was aluminum ingots. Unapproved materials were sometimes charged to the rotary furnaces. Wastes included baghouse dust and slag from the rotary furnaces. One estimate of the waste generation rate was 90-120 cubic yards per week approved as a special waste for disposal at a permitted solid waste disposal facility. It is unknown if any of this waste was ever taken to such a facility. Much of the waste was dumped on-site, and some of this may have been buried. The dump had an ammonia odor, was not fenced in on all sides, and often was burning. The Knox County Department of Air Pollution Control received numerous complaints about the facility, performed many inspections, and cited many violations.

Operations ceased sometime after May 1994.

1.64 Climatology

East Tennessee does not lie directly within any of the principle storm tracks that cross the country. The area is influenced primarily by storms that pass along the Gulf Coast and thence up the Atlantic Coast, and to a lesser extent by those that pass northeastward from Oklahoma to Maine.

TEMPERATURE

The difference in elevation between mountain top and valley in East Tennessee causes a considerable variation in temperature. The mean annual temperature of East Tennessee, based upon records from Chattanooga, Knoxville, and Bristol is between 57 and 58 F. Temperature extremes of -32 F in Johnson City and 111 F in Blount County have been recorded. July is the hottest month and January is the coldest. The usual date of the last killing frost ranges from March 30 in Hamilton County to May 10 in Johnson and Carter Counties. The usual date of the first

killing frost ranges from October 5 in Johnson and Carter Counties to October 30 in Hamilton County. The growing season varies from 150 to 210 days, depending upon latitude and elevation.

PRECIPITATION

Precipitation in East Tennessee is controlled in part by topography. It is heavier on the Cumberland Plateau and in the Unaka Mountains than in the Valley and Ridge province. Moist air masses reach the Valley and Ridge province comparatively dry because, in passing over the mountain on either side, their moisture is condensed and precipitated.

Rainfall is well distributed in the study area throughout the year. Knoxville's wettest months are January, February, and March (averaging 4.66, 4.51, and 5.05 inches, respectively) and the driest are September, October, and November (averaging 2.68, 2.62, and 3.07 inches, respectively). Snow occurs only occasionally and lightly in the lowland or valley land, and usually melts within a few hours or days except in shaded areas or near the tops of some of the highest ridges.

The topography largely controls the prevailing wind direction. The prevailing winds are from the northeast (15% of the time) and the southwest (12% of the time), but they are relatively light (mean speed is approximately 7.5 mph). Calm conditions exist 11% of the time (USDC/NOAA 1968).

2.0 PATHWAYS

2.1 Groundwater Pathway

2.11 Hydrogeology

The Smokey Mountain Smelters Site is located in the Southeastern Valley and Ridge physiographic province and the nonglaciated central region hydrogeologic setting. The land surface in the Valley and Ridge physiographic region is characterized by numerous ridges and intervening valleys, all trending in the northeast-southwest direction. This orientation is the result of folding and fracturing. Elevations in the area of the facility range between 813 (slightly lower during Fort Loudoun Reservoir drawdown) and 1160 (Rodgers Ridge) feet above mean sea level.

The rocks underlying the area of the Site are of the Middle Ordovician Chickamauga Group (Ottosee shale). This formation is from the Middle Ordovician Series, and is characterized by extensive Karst development.

Groundwater within formations of this group is restricted to fractures. The numerous fractures that have been created through the folding and faulting experienced by these formations are largely interconnected. The groundwater yield ranges from small to moderate quantities of water to wells and springs.

2.12 Groundwater Targets

It is estimated that the amount of groundwater used in the Knoxville area exceeds 10 million gallons per day. The 1990 Census revealed that in Knox County, individual wells were the source of water for 6026 housing units. This amounts to 15,400 persons, in the entire county, or, proportionally, approximately 1500 in the 4 miles radius, or 50.3 square miles, study area.

2.13 Groundwater Pathway Conclusions

A release to groundwater is suspected. On-site disposal of solid waste (baghouse dust, slag, dross, etc.) in an uncontained manner on permeable soil in a Karst region of shallow ground water has occurred. An unlined on-site lagoon receives surface water drainage from some of the disposal area. Heavy precipitation occurs in the area. The subsurface is permeable. There are several drinking water wells in the area, the nearest having a depth to water of 35 feet. Suspected nitrate, fluoride, and metals contaminants are mobile in groundwater.

There is at least moderate usage of groundwater resources in the area of the Site. The soil at the Site is porous, and the aquifer is shallow.

The atmospheric reactions of trace ammonia gases are known to include formation of ammonium sulfate and oxidation to nitrate.

Lithium and fluoride compounds, may be present due to the use of lithium carbonate, aluminum fluoride, and cryolite (Na_3AlF_6) in aluminum production.

2. 2 Surface Water Pathway

The Site is at the headwaters of an unknown tributary of Flenniken Branch. An on-site lagoon has been observed. The only surface water flow on the Site is due to stormwater runoff. The Site is not in the 100-year floodplain. The general direction of stormwater runoff flow is to the south, directly to the unknown tributary of Flenniken Branch. The unnamed tributary, Flenniken Branch, and Knob Creek are classified for Fish and Aquatic Life, Recreation, Irrigation, and Livestock Watering and Wildlife by the State of Tennessee. The remaining thirteen and four-tenths miles of the fifteen mile surface water pathway is the Fort Loudoun Lake (Tennessee River), which includes a small portion of Knob Creek and Flenniken Branch in its embayment. It is classified for Domestic Water Supply, Industrial Water Supply, Fish and Aquatic Life, Recreation, Irrigation, and Livestock Watering and Wildlife by the State of Tennessee.

2.21 Surface Water Targets

There are many surface water targets along the 15-mile surface water pathway. These targets include users of 1.6 miles of Flenniken Branch and the tributaries receiving surface water flow from the Site, and 13.4 miles of the Tennessee River (Fort Loudoun Lake) fishery and recreation areas, numerous wetland areas, livestock, and wildlife.

There are many surface water targets along the 15-mile surface water pathway. These targets include users of 13.4 miles of the Tennessee River (Fort Loudoun Lake) fishery and recreation areas, numerous wetland areas, livestock, and wildlife.

2.22 Public Drinking Water Intakes

There are no public drinking water intakes along the 15-mile surface water pathway associated with the Site.

The Knoxville Utilities Board intake is located at River Mile of the River, upstream of the portion of the River included in the 15-mile surface water pathway associated with the Site.

2.23 Fisheries

The portions of the River in the 15-mile surface water pathway associated with the Site are fisheries. These portions of the Rivers are classified for Fish and Aquatic Life.

The 13.4 mile portion of the Tennessee River (Fort Loudoun Lake) in the 15-mile surface water pathway associated with the Site is a fishery. This portion of the River is classified for Fish and Aquatic Life.

2.24 Sensitive Environments

The sensitive environments in or adjacent to the 15-mile surface water pathway include several wetlands. The closest wetland appears to be approximately 1.6 mile downstream of the Site, in the Flenniken Branch embayment of Fort Loudoun Lake (Tennessee River).

Endangered species and critical or sensitive habitat are as reported in the "Project review information for endangered species and critical or sensitive habitat". Records indicate threatened and/or endangered species

within an approximate four miles radius. The I. C. King Knox County Park land area surrounds most of the Flenniken Branch and Knob Creek embayment of Fort Loudoun Lake (Tennessee River).

2.25 Surface Water Pathway Conclusions

The potential exists for contaminants to be, and to have been, released to the surface water. It does not appear that the potential releases could significantly impact any public drinking water intake, but potential exists for impacts to residences, fisheries and recreation areas, aquatic life, commercial areas, wetlands, livestock, wildlife, and receptors of irrigated food crops.

A release to surface water is suspected. Surface water flows to an unnamed tributary of Flenniken Branch which is adjacent to the Site. An estimated 1000 cubic yards of uncontained waste is located in an area where precipitation is sometimes heavy. Hazardous substances found in the wastes and in the sediment include contaminants harmful to fisheries and sensitive environments. Some of the detected hazardous substances are bioaccumulative.

2.3 Soil Exposure Pathway

2.31 Site Soil Conditions

The Smokey Mountain Smelters Site lies in a moderately dense commercial and residential area adjacent to the Knoxville City Limit. The Site can be accessed by people because the Site property boundaries are not completely fenced to prevent access to the facility. There are many entrances to the main building. It is believed that unauthorized entries, including entries by children, into the building and onto the disposal area have occurred.

An estimated 1000 cubic yards of uncontained wastes are on-site. Particulate migration could occur, especially since a large portion of the wastes is baghouse dust. Historical emissions could have caused migration of particulates to off-site locations.

2.32 Soil Exposure Targets

An estimated 64,408 people live within four miles of the Site, based on the 1990 census data. There is no resident population. Access to the site is unrestricted, thus, soil exposure could occur if unauthorized persons enter the facility. Potential targets along the on-site soil pathway appear to be adults and children from area neighborhoods, and vagrants. Potential targets along the off-site soil pathway appear to be adults and children from area neighborhoods, vagrants, and visitors to commercial areas.

The nearest presently operating daycare facility, school, and residence are over 200 feet away from suspected areas of contamination at the Site. The Montgomery Village Ministry plans to open a daycare facility closer to the Site in January 1998.

2.33 Soil Exposure Pathway Conclusions

There is no known resident population. The nearest school and daycare facility are more than 200 feet away from the areas of known contamination. The nearest residences are in Montgomery Village, a group of multiple housing units, slightly more than 200 feet to the east. The nearest residences to the northeast are more than 200 feet away from areas of known contamination, however, one residence appears to be on or very near to Parcel #6, which may have been previously owned by the Site owner. Hazardous substances were found in the main building and scattered throughout the southern half of the property. Particulate migration via the air pathway could occur, especially from the active facility and in the northeast and southwest directions, which would increase the possibility of exposure via the soil pathway. No samples were collected from off-site where hazardous constituents could have migrated via the air pathway. The air migration pathway is primarily to the northeast and southwest, the directions of the prevailing winds. Access to the site is not controlled. Hazardous

substances are present, so exposure can occur when unauthorized entry to the site occurs. The presence of hazardous substances contaminating the soil at this site has been confirmed, but definition of the threats posed by the soil exposure pathway is not complete.

2.4 Air Pathway

2.41 Site Conditions

The Smokey Mountain Smelters Site lies in a moderately dense commercial and residential area adjacent to the Knoxville City Limit. It is believed that unauthorized entries into the building and onto the disposal area have occurred.

An estimated 1000 cubic yards of uncontained wastes are on-site. By observation and air monitoring, the waste has been found to be emitting ammonia to the atmosphere. Particulate migration could occur, especially since a large portion of the wastes is baghouse dust. The prevailing winds are to the southwest and northeast, where there are primary targets.

2.42 Air Pathway Targets

An estimated 64,408 people live within four miles of the Site, based on the 1990 census data. 207 persons (primary targets) reside within $\frac{1}{4}$ mile. There is no known resident population. Access to the site is unrestricted, thus, exposure via air could occur if unauthorized persons enter the facility. Potential targets along the on-site air pathway appear to be adults and children from area neighborhoods, and vagrants.

The nearest presently operating daycare facility, school, and residence are over 200 feet away from suspected areas of contamination at the Site. The Montgomery Village Ministry plans to open a daycare facility closer to the Site in January 1998.

2.43 Air Monitoring

Air sample locations are shown in Figure IV and in the photographs. Passive dosimeter tubes were placed at seven on-site locations, and readings were taken after four hours. The sample locations are shown in Figure IV and in the photographs. Sample #PDT-01 was collected at ground level at a disturbed waste pile. Sample #PDT-02 was collected near Sample #PDT-01, but at 3 feet elevation above the waste pile. Sample #PDT-03 was collected at the water level in the lagoon. Sample #PDT-04 was collected at a pile of waste blocks inside the main building. Sample #PDT-05 was collected inside the boring formed by collection of Sample #WA-04 eight days previously. Sample #PDT-06 was collected near Sample #PDT-05, but at the waste pile surface. Sample #PDT-07 was collected at the Sample #WA-02 location.

The odor of ammonia was detected by more than one TDSF employee during Site inspections. The odor threshold for ammonia in air is 46.8 ppm.

2.44 Air Pathway Conclusions

The Smokey Mountain Smelters Site appears to pose a threat to human health and/or the environment via the air pathway. Air monitoring was performed at the site and ammonia was detected. The large quantity of wastes, uncontrolled access to the Site, the possibility of particulate emissions, and the presence of primary targets make further investigation of exposure via the air pathway of primary importance.

3.0 SAMPLING INVESTIGATION

A total of twenty-three samples, including one quality control sample, are scheduled to be collected during this Site Investigation. This sampling schedule is subject to modification by conditions encountered in the field, but is tentatively planned as outlined in the following subsections. The Proposed Sample Location Plan, Figure 2, and the Off-Site Sample Location Maps, Figures 3A-E, indicate the proposed sampling locations. The sample collection sequence, codes, types, locations, and sample justification, for each sample proposed for the Smokey Mountain Smelters SI, are outlined in Table 3.

3.1 Waste and Leachate Sampling

Waste samples will be collected during this field sampling event. If leachate is observed, a sample of it may be collected in place of a waste sample. Three composite samples of waste (including one duplicate) will be collected from 0-2 feet deep. Waste sample locations are as shown in Figure 2, "Site Sketch/Proposed Sample Locations".

3.2 Surface and Subsurface Soil Sampling

It is proposed to collect five surface and four subsurface soil samples for a total of eight soil samples during the SI. Six of these soil samples (three sets, each comprised of a surface sample and a subsurface sample) are scheduled to be collected in the vicinity of on-site features, one set at a transformer station, one set at a former tank location, and one set at a drum disposal area. A surface soil sample, only, will be collected from a nearby residential area. One set of background samples, from a location having the same soil types (gullied land: Armuchee and Litz soil materials, G_E, adjacent to eroded rolling phase of Sequoia silty clay loam, S_K, and Leadvale and Whitesburg silt loams, L_C, or L_D,) as that soil on-site, will be collected from a nearby area. This background location will be sufficiently distant from the Site to minimize potential impact from the Site and other nearby Superfund Sites (Witherspoon Landfill, Site # 47-514, and Screen Arts, Inc., Site # 47-530, both at 1630 Maryville Pike). Subsurface soil samples will be collected two feet deep with a hand auger. Surface soils will be collected from 0 to 1.0 feet deep, with the grab sample for volatile organics being collected first from a depth of 0-3 inches. Surface and subsurface soil sample locations are as shown in Figure 2, "Site Sketch/Proposed Sample Locations" and Figure 3, "Off-Site Sample Locations".

3.3 Surface Water and Sediment Sampling

Four surface water and five sediment samples are proposed to be collected from the surface water pathway. Two surface water (including one duplicate) and two sediment samples will be collected from locations downstream of the probable point of entry from the Site. One of these surface water/sediment sets will be collected as near the Site as possible, and the other will be collected at the fishery. One background water and sediment sample will be collected upstream of the probable point of entry, or at a nearby stream not impacted by the Site and having similar soil and geologic characteristics, if water is not present upstream of the probable point of entry. On-site surface water and sediment in the lagoon and one other sediment sample from an on-site drainway will be sampled. Surface water and sediment sample locations are as shown in Figure 2, "Site Sketch/Proposed Sample Locations" and Figure 3, "Off-Site Sample Locations".

3.4 Groundwater Sampling

One of the nearest wells and one background well will be sampled. These wells are within the Ottosee Shale geologic area. Groundwater sample locations are as shown in Figure 3E, "Potential Background Groundwater Sample Locations".

3.5 Background Sampling/Quality Control Sampling

The proposed sample schedule outlined in the preceding subsections includes the background/control samples required for this investigation. One background/control sample will be collected of groundwater, surface water, sediment, subsurface soil, and surface soil.

One quality control sample is scheduled to be collected for this investigation. This duplicate sample will be collected at one of the on-site waste sample locations. The duplicate sample will be assigned the waste sample code, not the QC code.

3.6 Sample Coding

Samples will be coded according to EPA guidelines, as shown in TABLE 1, below.

TABLE 1 - STANDARD SAMPLE CODES			
Water Samples	Soil Samples	Additional Codes	
PW - Private Well	SS - Surface Soil	AR - Air	QC - Quality Control
PB - Public (Municipal) Well	SB - Subsurface Soil	SL - Sludge	TB - Trip Blank
MW - Monitoring (Permanent) Well	SZ - Saturation Zone	WA - Waste	FB - Field Blank
TW - Temporary (Well Point) Well	CS - Composite Soil	DR - Drum	ER - Equipment Rinsate
IW - Industrial Well	LS - Leachate Soil	AQ-Aquatic	
SW - Surface Water	SD - Sediment	(Biological)	
SP - Spring Water			
LW - Leachate Water			

All sample codes will consist of 7 characters in the following format: Site Name - Sample Type - SampleNumber

3.7 Analysis Requested/Contract Laboratory

Samples will be analyzed for the Target Compound List (TCL), the Target Analyte List (TAL), and special compounds selected due to the Site's history of fertilizer management and aluminum smelting. These lists include selected purgeable organic compounds, selected extractable organic compounds, selected pesticides, all PCB's, selected metals, cyanide, ammonia, fluoride, nitrate, nitrite, and sulfate. Fluoride, nitrate, nitrite, and sulfate will be analyzed in water samples only. Analyses will be performed by the Tennessee Department of Health, Bureau of Laboratory Services, according to U.S. EPA contract laboratory procedures. Contract analyses may be required for certain special compounds.

3.8 Analytical and Container Requirements

Sample containers used will be in accordance with the requirements specified in the Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual; U.S. EPA, Region IV, Environmental Services Division, February 1991, and the Handbook for Sampling and Sample Preservation of Water and Wastewater; EPA 600/482029, September, 1982. A description of containers required is presented in TABLE 2.

TABLE 2 - SAMPLE CONTAINERS		
Analysis	Container	
	Liquid Sample (Preservative*)	Solid Sample (Preservative*)
Ammonia	500 ml., plastic (1 ml sulfuric acid)	16 oz. glass or plastic (None)**
Cyanide	1 liter plastic, special (NaOH to pH>12, chk-treat Cl)	16 oz. plastic cup or glass jar, 1 per sample (None)**
Extractable Organics	1 gallon amber glass jug, acetone rinsed container (None)	16 oz. jar, Teflon liner, 1 per sample (None)
Fluoride	1 liter plastic or 1 gallon plastic (None)**	(water only)
Mercury	500 ml., plastic (HNO ₃ , pH<2)	16 oz. plastic cup or glass jar, 1 per sample (None)**
Metals	1 liter plastic (HNO ₃ , pH<2)	16 oz. plastic cup or glass jar, 1 per sample (None)**
Nitrate	1 liter plastic or 1 gallon plastic (None)** AND 500 ml., plastic (1 ml sulfuric acid)	(water only)
Nitrite	1 liter plastic or 1 gallon plastic (None)**	(water only)
Radiochemical	1 gallon plastic (None)***	16 oz. plastic (None)***
Sulfate	1 liter plastic or 1 gallon plastic (None)**	(water only)
Volatile Organics	40 ml. amber vial, Teflon septum, 4 per sample (HCl)	4 oz., glass jar, Teflon liner, 1 per sample (None)
All	➤1 liter plastic or 1 gallon plastic (None) ➤500 ml., plastic (1 ml sulfuric acid) ➤1 liter plastic, special (NaOH to pH>12,chk-treat Cl) ➤500 ml., plastic (HNO ₃ , pH<2) ➤1 liter plastic (HNO ₃ , pH<2) ➤40 ml. amber vial, Teflon septum, 4 per sample (HCl) ➤1 gallon amber glass jug, acetone rinsed container (None) ➤1 gallon plastic (None)	➤16 oz. glass or plastic (None) ➤4 oz., glass jar, Teflon liner, 1 per sample (None) ➤16 oz. jar, Teflon liner, 1 per sample (None) ➤16 oz. plastic (None)
	total number of containers per liquid sample = 11 total number of SAMPLES = 6	total number of containers per solid sample = 4 total number of SAMPLES = 17

* Cooled to 4°C after collection ** One container per sample for multiple parameters *** Separate container required

TOTAL NUMBER OF CONTAINERS FOR ALL SAMPLES		
MEDIA	CONTAINER TYPE	TOTAL NUMBER
water	1 gallon amber glass jug, acetone rinsed container (None)	6
	40 ml. amber vial, Teflon septum	24
	1 liter plastic (HNO ₃ , pH<2)	6
	500 ml., plastic (HNO ₃ , pH<2)	6
	1 liter plastic, special (NaOH to pH>12,chk-treat Cl)	6
	500 ml., plastic (1 ml sulfuric acid)	6
	1 liter plastic or 1 gallon plastic (None)	6
	1 gallon plastic (None)	6
soil/ sediment	16 oz. glass or plastic (None)	17
	4 oz., glass jar, Teflon liner, 1 per sample (None)	17
	16 oz. jar, Teflon liner, 1 per sample (None)	17
	16 oz. plastic (None)	17

3.9 General Methodology

All sample collection, sample preservation, and chain-of-custody procedures used during this investigation will be in accordance with the standard operating procedures as specified in Section 3 and 4 of the Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual; U.S. EPA, Region IV, Environmental Services Division, February 1991.

All laboratory analyses and laboratory quality assurance procedures used during this investigation will be in accordance with standard procedures and protocols as specified in the Analytical Support Branch Operations and Quality Assurance Manual; U.S. EPA, Region IV, Environmental Services Division; revised June 1, 1985, or as specified by the existing U.S. EPA standard procedures and protocols for the contract analytical laboratory program.

4.0 FIELD HEALTH AND SAFETY PLAN

4.1 Purpose

The purpose of this safety plan is to assign responsibilities, establish personnel protection standards, establish mandatory safety operating procedures, and provide for contingencies that may arise while conducting this Site Screening Investigation. All aspects of the field operations must comply with the U.S. EPA "Standard Operating Safety Guides" section of Personnel Protection and Safety course manual and Occupational Safety and Health Administration regulations (29 CFR 1910.120).

4.2 Site Safety Officer

The Site Safety Officer (SSO) for this Site Investigation is: Burl H. Maupin, Regulatory Project Manager, TDSF-Knoxville Environmental Assistance Center.

Designated alternate SSO: Lee Barron

The Site Safety Officer will assure that appropriate personnel protection equipment is available and properly utilized by all members of the field investigation team. He will also assure that proper emergency first aid equipment is available (eye wash station, first aid kit, etc.). The SSO's responsibilities will include oversight of work practices that will insure personnel safety, and correction of work practices or conditions that are or may appear to be hazardous. The SSO will have ultimate authority on all safety decisions and can suspend investigation operations if required safety procedures are not followed or if conditions become too hazardous for the level of protection provided.

4.3 Protective Clothing

Modified level D personal protective equipment will be worn by on-site personnel during sampling activities. Modified level D consists of normal work clothes worn beneath tyvek coveralls and disposable nitrile gloves, and includes safety glasses, steel-toed boots, and disposable outer boots. Variations to this planned level of protection will be made by the site safety officer if site conditions warrant up-grading to a higher level.

Level C protection will include the addition of air-purifying, full-face respirators equipped with NIOSH approved cartridges for respiratory protection against ammonia, methylamine, and particulates (AM/MA/P100(GMD-P100 TYPE)) and special prescription eyeglass kits (if needed).

Additional protective equipment including hearing protection, and hard hats will be utilized as site conditions warrant.

TABLE 3
LIST OF SEQUENTIAL SAMPLES' SCHEDULE, CODES, TYPES, LOCATIONS, and JUSTIFICATIONS
SMOKEY MOUNTAIN SMELTERS

	SAMPLE ID	SAMPLE TYPE	LOCATION/JUSTIFICATION	TEAM
D A Y	SMS-WA-07	Waste	South Disposal Area/Presence of hazardous substance	AW
	SMS-SS-04	Surface Soil	On-site drum storage-disposal/Presence of hazardous substance	AW
	SMS-SB-04	Subsurface Soil	On-site drum storage-disposal/Presence of hazardous substance	AW
	SMS-SS-03	Surface Soil	On-site tank farm/Presence of hazardous substance	AW
	SMS-SB-03	Subsurface Soil	On-site tank farm/Presence of hazardous substance	AW
	SMS-SS-02	Surface Soil	On-site transformer station/Presence of hazardous substance	AW
	SMS-SB-02	Subsurface Soil	On-site transformer station/Presence of hazardous substance	AW
	SMS-SW-03	Water	At First Occurrence of Water in the Unnamed Tributary of Flenniken Branch/Presence of hazardous substance	MB
	SMS-SD-05	Sediment	At First Occurrence of Water in the Unnamed Tributary of Flenniken Branch /Presence of hazardous substance	MB
	SMS-SW-02	Water	On-site lagoon/ Presence of hazardous substance	MB
	SMS-SD-03	Sediment	On-site lagoon/ Presence of hazardous substance	MB
	SMS-WA-05	Waste	Basin Behind Maintenance Shed/Presence of hazardous substance	MB
O N E	SMS-WA-06	Waste	Basin Behind Maintenance Shed/Presence of hazardous substance (duplicate)	MB
	SMS-SD-04	Sediment	On-site drainway/ Presence of hazardous substance	MB
D A Y	SMS-GW-02	Groundwater	Mary Knox Tavern/Presence of hazardous substance	BA
	SMS-SS-05	Surface Soil	Gullied Land, Armuchee and Litz Soil Materials at Montgomery Village Apartments/ Presence of hazardous substance	MW
	SMS-SS-01	Surface Soil	Gullied Land, Armuchee and Litz Soil Materials - Vulcan/ Background	MW
	SMS-SB-01	Subsurface Soil	Gullied Land, Armuchee and Litz Soil Materials - Vulcan / Background	MW
	SMS-SW-01	Water	Unnamed Tributary of Flenniken Branch/Background	BA
	SMS-SD-02	Sediment	Unnamed Tributary of Flenniken Branch /Background	BA
	SMS-GW-01	Groundwater	9038,9039,9040,9042,9043,or1638-1656(TDEC-DWS)/Background	BA
	SMS-SW-04	Water	At First Occurrence of Fishery in Flenniken Branch / Presence of hazardous substance	MBA
	SMS-SD-06	Sediment	At First Occurrence of Fishery in Flenniken Branch / Presence of hazardous substance	MBA
T W O				

4.4 Safety Equipment

Prior to and during sampling activities the work environment will be monitored to evaluate the associated risks. This evaluation will include monitoring the sampling areas with a Ludlum sodium iodide or BICRON radiation meter and monitoring the breathing zone with a H-Nu photo ionization detector and/or an Organic Vapor Analyzer flame ionization detector, and an MSA LEL/O₂ Meter. If conditions more hazardous than those presently anticipated are encountered (such as an LEL > 10%, or a PID/FID reading > 200 ppm), project operations shall cease until additional protection can be acquired or conditions return to a less hazardous state.

4.5 Site Specific Safety Instructions

Prior to the start of project operations, the site safety officer will discuss health and safety concerns with project personnel. This will include such physical hazards as the safe operation of soil boring and sampling equipment; the risk of slips, trips and falls; and hypothermia associated with outdoor activities during the winter season. The chemical hazards associated with sampling soil and water contaminated by organic compounds and metals will also be covered. Volatile, toxic organic chemicals may have been stored at the facility; therefore, the ambient air must be closely monitored during sampling activities.

The health and safety briefing will outline the procedures to be followed during an emergency situation, and the route to the nearest hospital. The nearest hospital is the Baptist Hospital of Knox County, 435 Second Street, Knoxville (one-half mile from the Site).

Emergency Phone Numbers

Ambulance Service, Knoxville Fire Department.....	911
University of Tennessee Medical Center, Emergency.....	544-8877
Knoxville/Knox County Emergency Management Agency.....	215-2297
National Response Center.....	800-424-8802
EPA Region IV Emergency Response and Removal Branch, Removal/Cleanup Public Information Line.....	800-564-7577
EPA Region IV 24 Hour Spill Reporting Number.....	(404) 562-8700

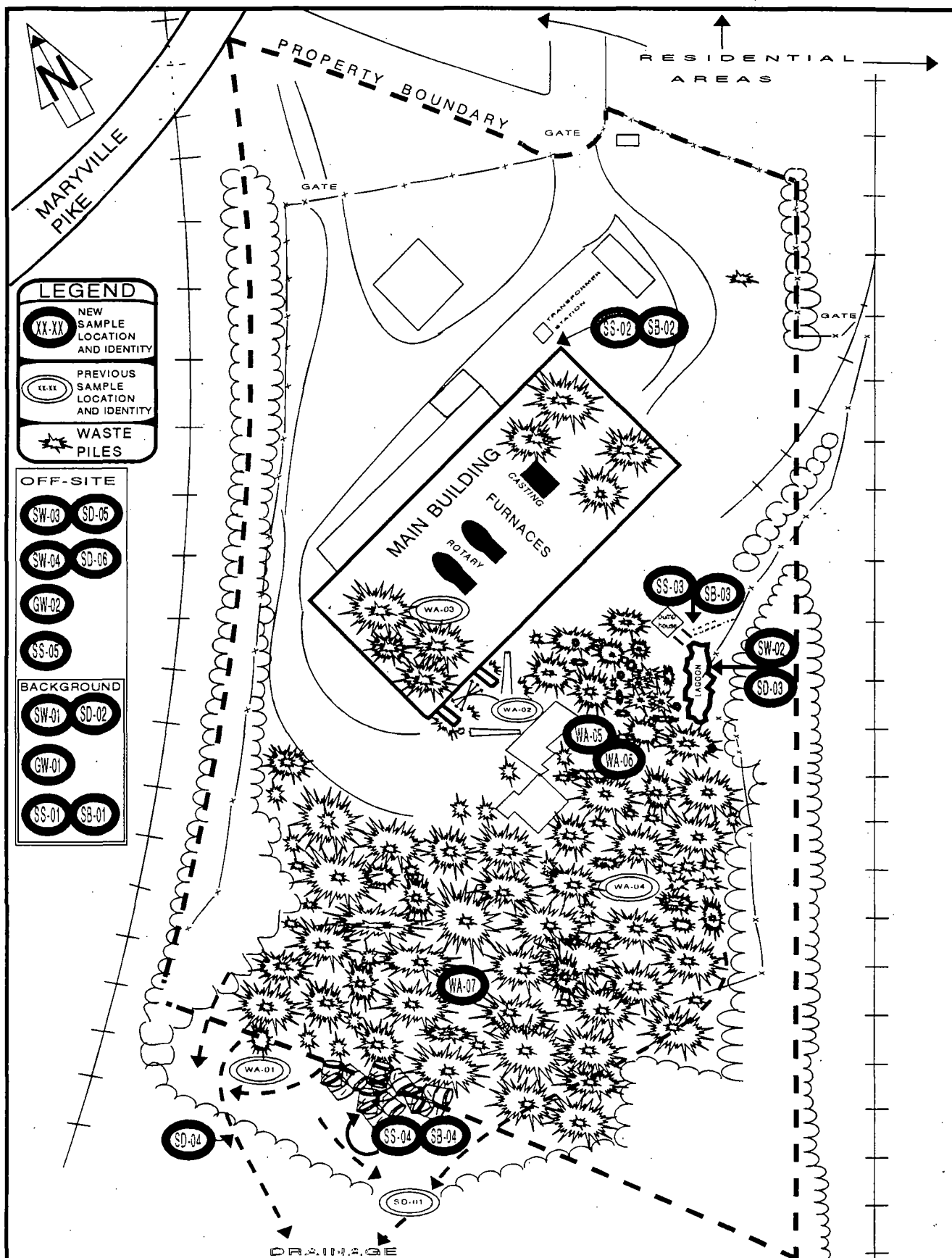
REFERENCES

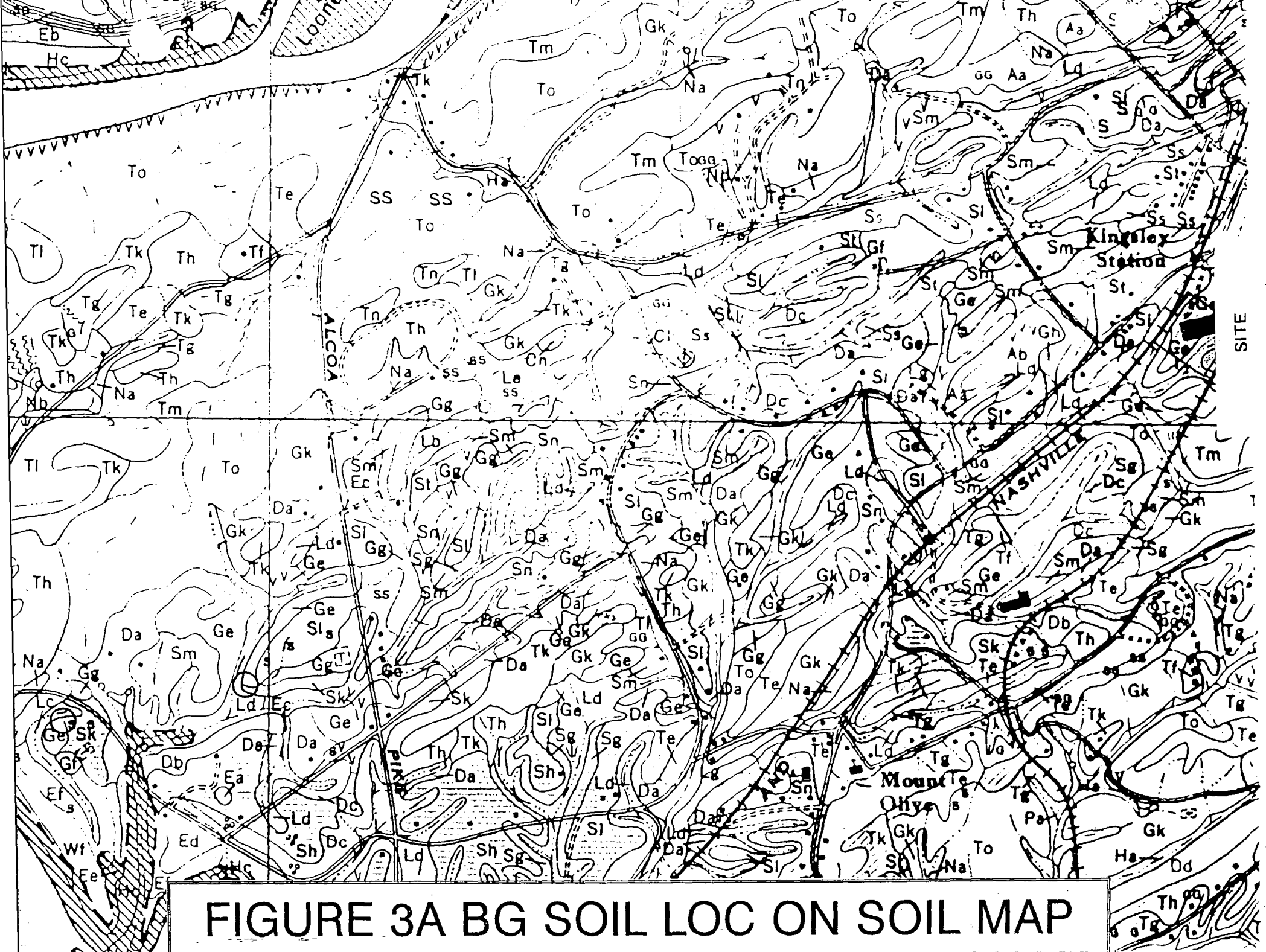
TDSF/KFO. 1998. "Preliminary Assessment Report, Smokey Mountain Smelters Site, Knoxville, Knox County, Tennessee," Tennessee Division of Superfund/Knoxville Field Office. TDSF Site No: 47-559. U.S. EPA # TND098071061. January 1998.

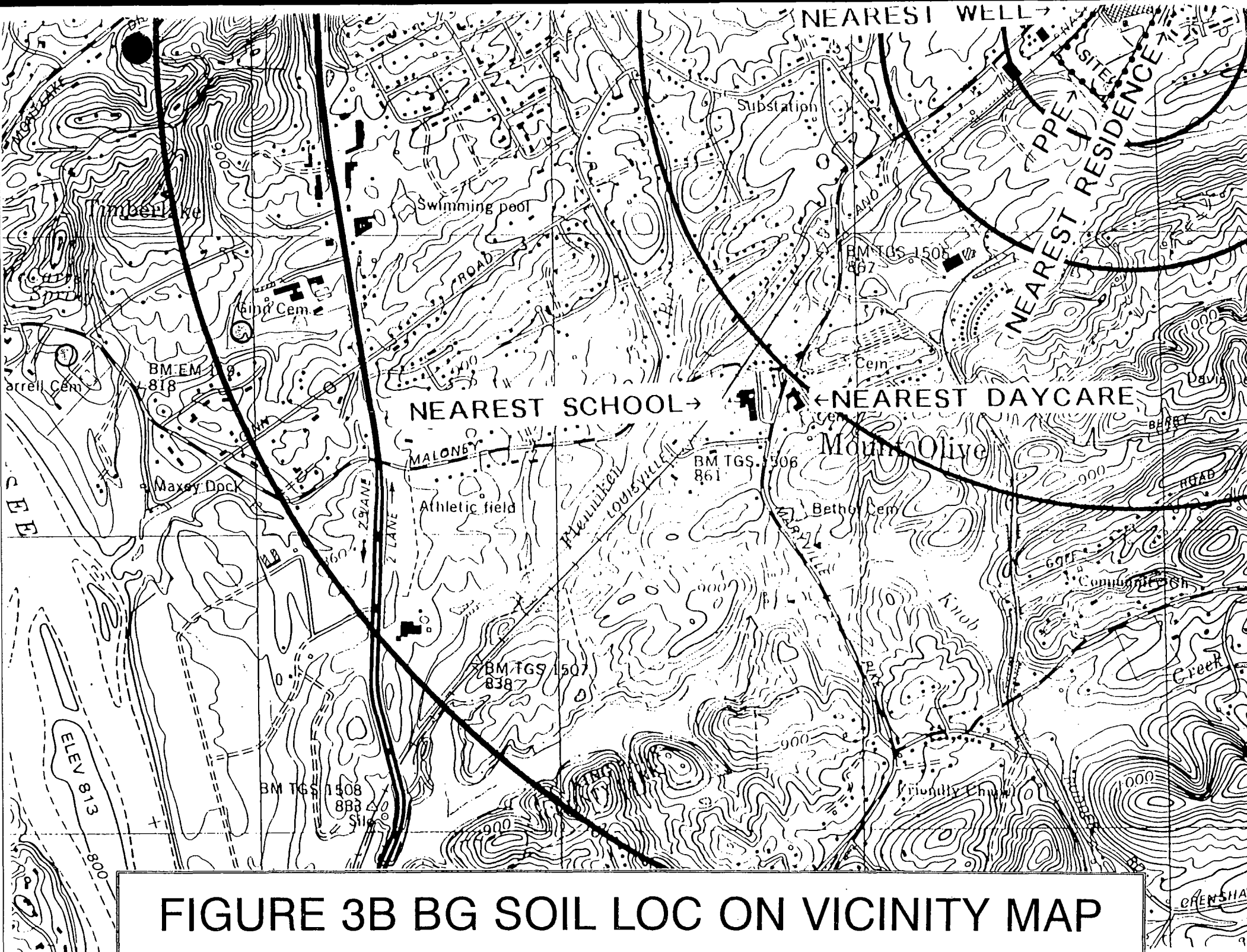
U.S.D.O.E. 1997. "Work Plan for the Phase II Remedial Investigation for the David Witherspoon, Inc., Landfill 1630 Site, Knoxville, Tennessee." August.

Figure 2

SITE INVESTIGATION SMOKEY MOUNTAIN SMELTERS Site Sketch / Proposed Sample Location Knox County, TN TDSF # 47-559







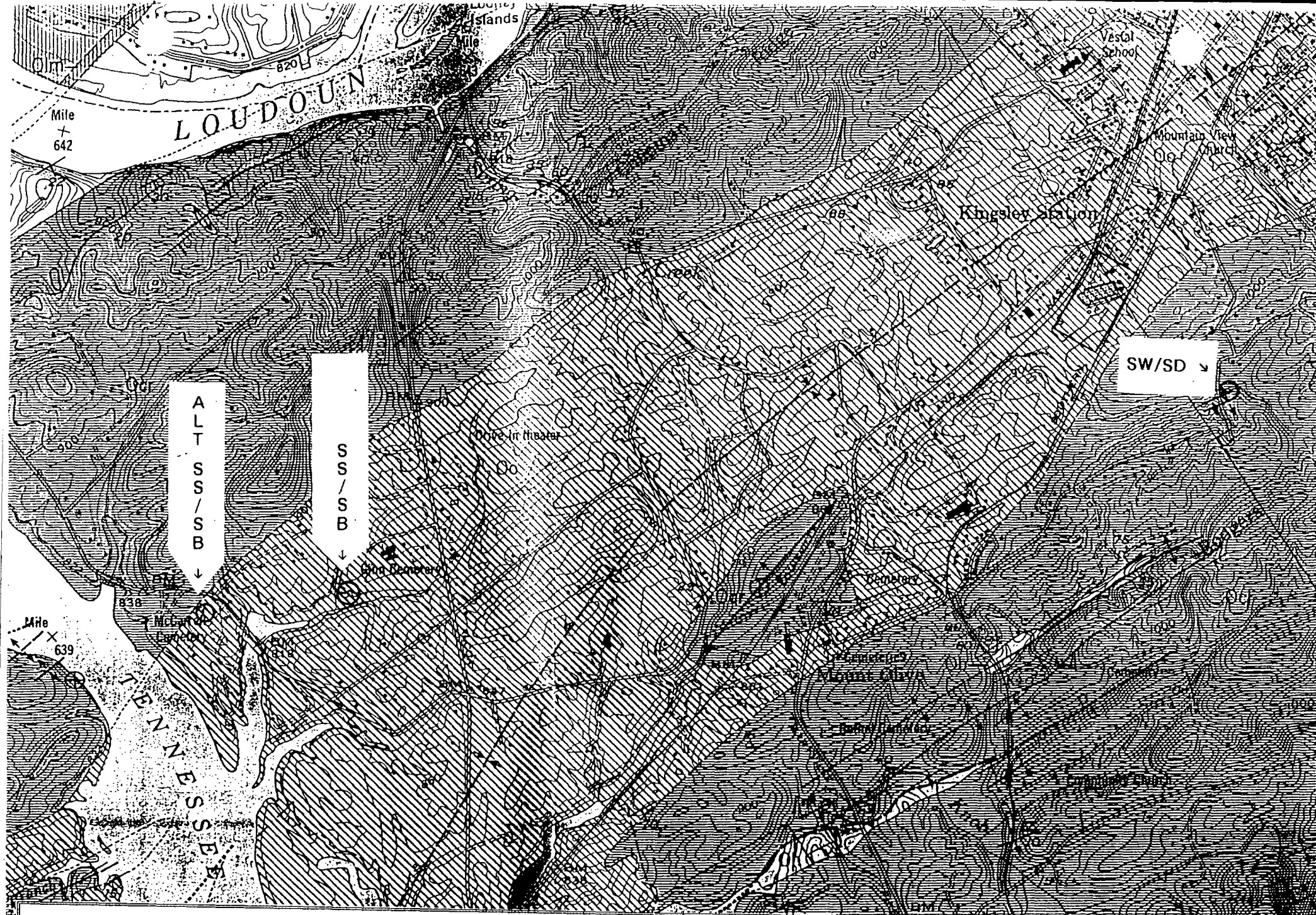


FIGURE 3D BG SS,SB,SW/SD LOC ON GEOLOGIC MAP

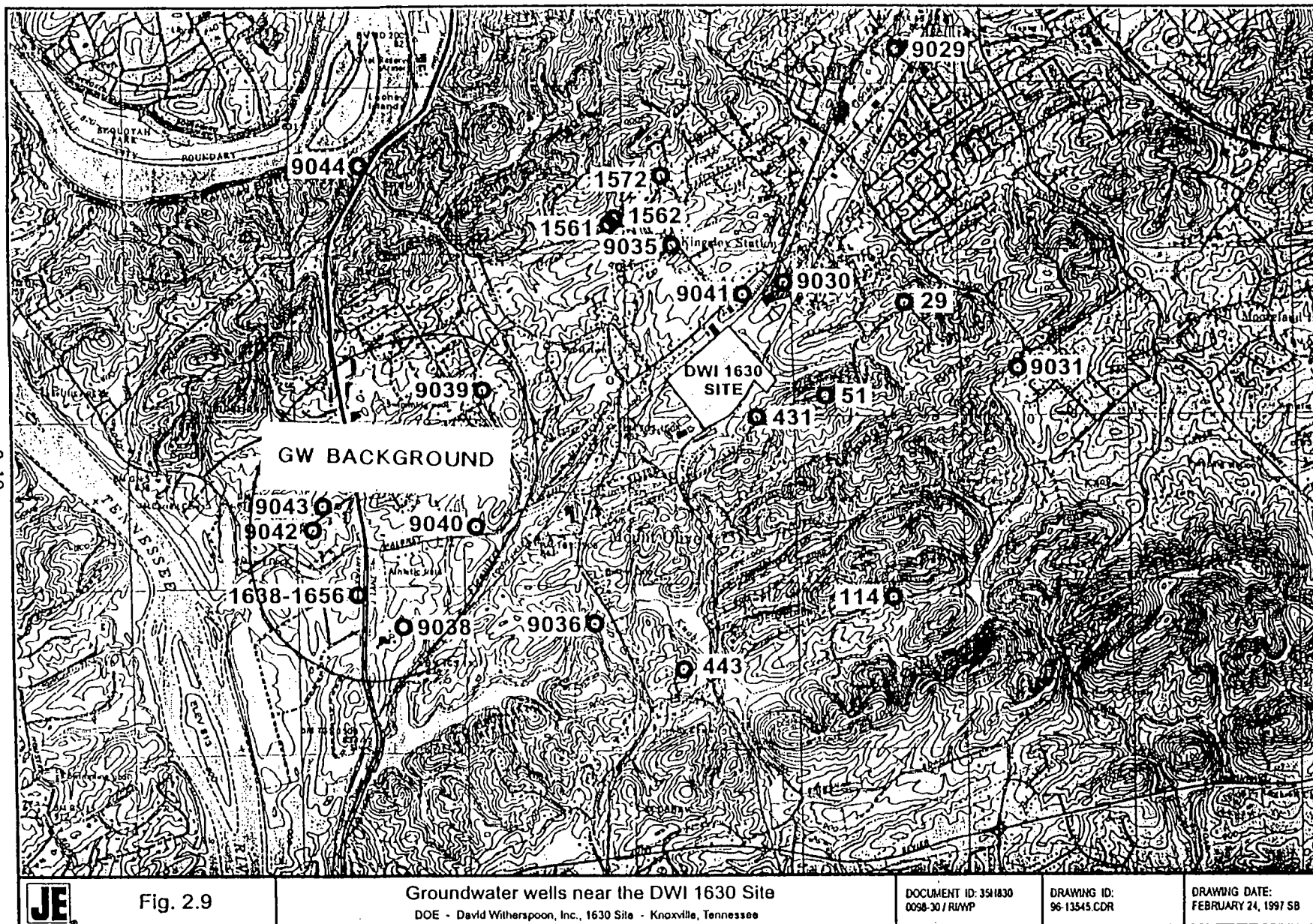


FIGURE 3E BG GW LOCATIONS

Table 2.3. Groundwater wells in South Knox County near the DWI 1630 Site,
Knoxville, Tennessee

Well number	State planner coordinates		Owner	Completion date	Total depth (ft)	AQ depth (ft)	Static level (ft)	Total yield (gpm)	Casing depth (ft)	Casing type	Use
	X	Y									
443	2580955	576544	Norris, F.	9/28/68	216	195	N/A	25	50	Steel	N/A
9038	2575186	576928	Davis, P. H.	N/A	135	80	25	N/A	70	N/A	Home
9036	2578968	577109	Neas, M.	N/A	47	N/A	12	N/A	10	N/A	Home
114	2584634	577633	Roberts, E.	7/22/64	137	78	60	10	63	N/A	Home
51	2581308 (?)	579282 (?)	Richards, C.	3/10/64	173	150	135	20	120	Steel	Home
431	2581687	580807	Evans, A.	8/2/68	333	320	175	13	8	Steel	Home
9039	2576652	581611	Elliott, B.	N/A	78	N/A	5	N/A	40	N/A	Home
9040	2576651 (?)	581611 (?)	King, O. M.	N/A	165	N/A	40	N/A	35	N/A	N/A
9031	2587163	582542	Easglor, H. L.	N/A	190	N/A	60	N/A	N/A	N/A	Home
29	2584832	583807	Maxwell	8/29/63	182	N/A	82	N/A	70	Steel	Home
9041	2581625	583739	Wilson, W. A.	0/19/36	104	N/A	14	N/A	104	N/A	Home
9030	2582606	584063	Knox Fertilizer	N/A	700	N/A	300	100	N/A	N/A	Industrial
9035	2580208	584619	Rogers, W. R.	N/A	121	80	44	N/A	40	N/A	Home
1561	2579051	584898	Becker, S.E.	2/8/82	185	115	50	60	73	Steel	N/A
1562	2579131	585001	Simmons, H.	2/8/82	228	210	70	20	35	Steel	N/A
1572	2579929	586130	Wieggers, G.	1/6/82	300	N/A	90	10	186	Steel	Home
9044	2574173	586009	Dunford	N/A	71	N/A	35	N/A	N/A	N/A	Home
9042	2588461	579535	Dempster, J.	N/A	125	N/A	35	N/A	N/A	N/A	Home
9043	257336	578811	Ginna, A.	N/A	95	N/A	40	N/A	N/A	N/A	Home
9029	2584565	588656	Candors, M.	N/A	380	N/A	65	350	10	N/A	Industrial
1638	2574271	577415	UT #1	10/9/82	60	52	30	7	40	Steel	N/A
1639	2574271	577415	UT #1A	1/3/83	60	54	30	7	42	Steel	N/A

Table 2.3. (continued)

Well number	State planner coordinates		Owner	Completion date	Total depth (ft)	AQ depth (ft)	Static level (ft)	Total yield (gpm)	Casing depth (ft)	Casing type	Use
	X	Y									
1640	2574269	577516	UT #1B	1/3/83	60	51	N/A	8	42	Steel	N/A
1641	2574355	577316	UT #1C	1/3/83	60	N/A	N/A	N/A	42	Steel	N/A
1642	2574271	577415	UT #1D	1/3/83	60	N/A	N/A	N/A	44	Steel	N/A
1643	2574436	577418	UT #2	1/3/83	70	63	35	10	52	Steel	N/A
1644	2574271	577415	UT #2A	1/3/83	100	N/A	35	N/A	47	Steel	N/A
1645	2574271	577415	UT #3	1/3/83	100	65	30	7	44	Steel	N/A
1646	2574271	577415	UT #3A	1/3/83	100	N/A	30	N/A	46	Steel	N/A
1647	2574271	577415	UT #3B	1/3/83	100	N/A	30	N/A	44	Steel	N/A
1648	2574189	577413	UT #3C	1/3/83	100	N/A	30	N/A	42	Steel	N/A
1649	2574271	577415	UT #3D	1/3/83	100	N/A	30	N/A	42	Steel	N/A
1650	2574271	577415	UT #3E	1/3/83	100	N/A	30	N/A	42	Steel	N/A
1651	2574271	577415	UT #3F	1/3/83	100	N/A	30	N/A	43	Steel	N/A
1652	2574271	577415	UT #3G	1/5/83	100	N/A	35	N/A	42	Steel	N/A
1653	2574271	577415	UT #4	1/5/83	80	75	N/A	13	51	Steel	N/A
1654	2574271	577415	UT #5	1/5/83	90	80	30	12	61	Steel	N/A
1655	2574271	577415	UT #5A	1/5/83	100	N/A	N/A	N/A	42	Steel	N/A
1656	2574271	577415	UT #6	1/5/83	60	N/A	N/A	N/A	61	Steel	N/A

Source: Records of water wells, TDEC, Division of Water Supply

Notes: AQ depth: depth below land surface to the top of the shallowest aquifer or water-bearing zone tapped by the well. Static level: static water-level: depth from the land surface to the surface of the water standing in an idle well. Total yield: total yield of the well in gpm. Yields less than one-half gpm reported as zero. Casing depth: depth to the bottom of the water-tight casing installed in the well.

AQ = aquifer

DWI = David Witherspoon, Inc.

ft = foot

gpm = gallons per minute

N/A = not available

TDEC = Tennessee Department of Environment and Conservation

UT = The University of Tennessee

" Nonferrous Metals Manufacturing Point Source Category "

NARA (National Archives and Records Administration). 1996. Code of Federal Regulations, Title 40: Protection of Environment, Part 421: Nonferrous Metals Manufacturing Point Source Category, Subpart C, Item 421.30 (Washington D.C. Government Printing Office).

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

[Code of Federal Regulations]
[Title 40, Volume 15, Parts 400 to 424]
[Revised as of July 1, 1996]
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[CITE: 40CFR421.30]

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TITLE 40--PROTECTION OF ENVIRONMENT

CHAPTER I--ENVIRONMENTAL PROTECTION AGENCY--(Continued)

PART 421--NONFERROUS METALS MANUFACTURING POINT SOURCE CATEGORY--Table of Contents

Subpart C--Secondary Aluminum Smelting Subcategory

Sec. 421.30 Applicability: Description of the secondary aluminum smelting subcategory.

Source: 49 FR 8796, Mar. 8, 1984, unless otherwise noted.

The provisions of this subpart are applicable to discharges resulting from the recovery, processing, and remelting of aluminum scrap to produce metallic aluminum alloys.

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PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum product from direct chill casting	
Benzo(a)pyrene	(¹)	(¹)
Nickel .....	.731	.492
Fluoride	79.080	35.090

¹ There shall be no discharge allowance for this pollutant.

(l) Subpart B—Continuous Rod Casting Contact Cooling.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pound per million pounds) of aluminum product from rod casting	
Benzo(a)pyrene	(¹)	(¹)
Nickel .....	.057	.038
Fluoride	6.188	2.746

¹ There shall be no discharge allowance for this pollutant.

(m) Subpart B—Stationary Casting or Shot Casting Contact Cooling.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pound per million pounds) of aluminum product from stationary casting or shot casting	
Benzo(a)pyrene .....	.000	.000
Nickel .....	.000	.000
Fluoride .....	.000	.000

[49 FR 8792, Mar. 8, 1984; 49 FR 26739, June 29, 1984, as amended at 52 FR 25559, July 7, 1987]

§ 421.27 [Reserved]

Subpart C—Secondary Aluminum Smelting Subcategory

SOURCE: 49 FR 8796, Mar. 8, 1984, unless otherwise noted.

§ 421.30 Applicability: Description of the secondary aluminum smelting subcategory.

The provisions of this subpart are applicable to discharges resulting from

the recovery, processing, and remelting of aluminum scrap to produce metallic aluminum alloys.

§ 421.31 Specialized definitions.

For the purpose of this subpart:

(a) Except as provided below, the general definitions, abbreviations and methods of analysis set forth in part 401 of this chapter shall apply to this subpart.

(b) The term *product* shall mean hot aluminum metal.

(c) *At-the-source* means at or before the commingling of delacquering scrubber liquor blowdown with other process or nonprocess wastewaters.

§ 421.32 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best practicable control technology currently available.

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this subpart shall achieve the following effluent limitations representing the degree of effluent reduction attainable by the application of the best practicable technology currently available:

(a) The following limitations establish the quantity or quality of pollutants or pollutant properties, which may be discharged by a point source subject to the provisions of this subpart and which uses water for metal cooling, after application of the best practicable control technology currently available: There shall be no discharge of process wastewater pollutants to navigable waters.

(b) The following limitations establish the quantity or quality of pollutants or pollutant properties which may be discharged by a point source subject to the provisions of this subpart and which uses aluminum fluoride in its magnesium removal process ("demagging process"), after application of the best practicable control technology currently available: There shall be no discharge of process wastewater pollutants to navigable waters.

(c) The following limitations establish the quantity or quality of pollutants or pollutant properties controlled

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by this section, which may be discharged by a point source subject to the provisions of this subpart and which uses chlorine in its magnesium removal process, after application of the best practicable control technology currently available:

EFFLUENT LIMITATIONS	
Effluent characteristic	Average of daily values for 30 consecutive days shall not exceed—
	<p>Metric units (kilograms per 1,000 kg magnesium removed)</p> <p>English units (pounds per 1,000 lb magnesium removed)</p>
TSS	175
COD	6.5
pH	(¹)

¹ Within the range of 7.5 to 9.0.

(d) The following limitations establish the quantity or quality of pollutants or pollutant properties which may be discharged by a point source subject to the provisions of this subpart and which processes residues by wet methods, after application of the best practical control technology currently available:

EFFLUENT LIMITATIONS	
Effluent characteristic	Average of daily values for 30 consecutive days shall not exceed—
	<p>Metric units (kilograms per 1,000 kg of product)</p> <p>English units (pounds per 1,000 lb of product)</p>
TSS	1.5
Fluoride	0.4
Ammonia (as N)	0.01
Aluminum	1.0
Copper	0.003
COD	1.0
pH	(¹)

¹ Within the range of 7.5 to 9.0.

§ 421.33 Effluent limitations guidelines representing the degree of effluent reduction attainable by the application of the best available technology economically achievable.

Except as provided in 40 CFR 125.30 through 125.32, any existing point source subject to this subpart shall achieve the following effluent limitations representing the degree of efflu-

ent reduction attainable by the application of the best available technology economically achievable:

(a) Subpart C—Scrap Drying Wet Air Pollution Control.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pound's per million pounds) of aluminum scrap dried	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000

(b) Subpart C—Scrap Screening and Milling.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pound's per million pounds) of aluminum scrap screened and milled	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000

(c) Subpart C—Dross Washing.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pound's per million pounds) of dross washed	
Lead	3.043	1.413
Zinc	11.090	4.565
Aluminum	66.410	29.450
Ammonia (as N)	1,449.000	636.900

(d) Subpart C—Demagging Wet Air Pollution Control.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum demagged	
Lead	0.216	0.100
Zinc	0.786	0.324

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BAT EFFLUENT LIMITATIONS—Continued

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
Aluminum	4.711	2.090
Ammonia (as N)	102.800	45.180

(e) Subpart C—Delacquering Wet Air Pollution Control.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum delacquered	
Lead	0.093	0.043
Zinc	0.340	0.140
Aluminum	2.035	0.903
Ammonia (as N)	44.389	19.514
Total phenolics (4-AAP method) ¹	0.004	

¹ At the source.

(f) Subpart C—Direct Chill Casting Contact Cooling.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.372	.173
Zinc	1.356	.558
Aluminum	8.120	3.602
Ammonia (as N)	177.200	77.880

(g) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chlorine Demagging Wet Air Pollution Control is Not Practiced On-Site).

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum cast	
Lead	0.019	0.009
Zinc	0.068	0.028
Aluminum	0.409	0.182
Ammonia (as N)	8.931	3.926

(h) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chloride

Demagging Wet Air Pollution Control is Practiced On Site).

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000

(i) Subpart C—Stationary Casting Contact Cooling.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000

(j) Subpart C—Shot Casting Contact Cooling.

BAT EFFLUENT LIMITATIONS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000

[49 FR 8796, Mar. 8, 1984; 49 FR 26739, June 29, 1984, as amended at 49 FR 29794, July 24, 1984; 52 FR 25559, July 7, 1987]

§ 421.34 Standards of performance for new sources.

Any new source subject to this subpart shall achieve the following new source performance standards:

(a) Subpart C—Scrap Drying Wet Air Pollution Control.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum scrap dried	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000
Total suspended solids .....	.000	.000
Oil and grease .....	.000	.000
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(b) Subpart C—Scrap Screening and Milling.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum scrap screened and milled	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000
Total suspended solids .....	.000	.000
Oil and grease .....	.000	.000
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(c) Subpart C—Dross Washing.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of dross washed	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000
Total suspended solids .....	.000	.000
Oil and grease .....	.000	.000
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(d) Subpart C—Demagging Wet Air Pollution Control.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum demagged	
Lead	0.216	0.100
Zinc	0.786	0.324
Aluminum	4.711	2.090
Ammonia (as N)	102.800	45.180
Total suspended solids	11.570	9.252
Oil and grease	7.710	7.710
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(e) Subpart C—Delacquering Wet Air Pollution Control.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum delacquered	
Lead	0.093	0.043
Zinc	0.340	0.140
Aluminum	2.035	0.903
Ammonia (as N)	44.389	19.514
Total phenolics (4-AAP method) ¹	0.004	
Total suspended solids	4.995	3.998
Oil and grease	3.330	3.330
pH	(²)	(²)

¹ At the source.² Within the range of 7.0 to 10.0 at all times.

(f) Subpart C—Direct Chill Casting Contact Cooling.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.372	.173
Zinc	1.356	.558
Aluminum	8.120	3.602
Ammonia (as N)	177.200	77.880
Total suspended solids	19.940	15.950
Oil and grease	13.290	13.290
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(g) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chlorine Demagging Wet Air Pollution Control is Not Practiced On-Site).

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§ 421.35

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum cast	
Lead	0.019	0.009
Zinc	0.088 ¹	0.028
Aluminum	0.409	0.182
Ammonia (as N)	8.931	3.926
Total suspended solids	1.005	0.804
Oil and grease	0.670	0.670
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(h) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chlorine Demagging Wet Air Pollution Control is Practiced On Site).

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000
Total suspended solids .....	.000	.000
Oil and grease .....	.000	.000
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(i) Subpart C—Stationary Casting Contact Cooling.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000
Total suspended solids .....	.000	.000
Oil and grease .....	.000	.000
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

(j) Subpart C—Shot Casting Contact Cooling.

NSPS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Aluminum .....	.000	.000
Ammonia (as N) .....	.000	.000
Total suspended solids .....	.000	.000
Oil and grease .....	.000	.000
pH	(¹)	(¹)

¹ Within the range of 7.0 to 10.0 at all times.

[49 FR 8796, Mar. 8, 1984, as amended at 49 FR 29794, July 24, 1984; 52 FR 25559, July 7, 1987]

§ 421.35 Pretreatment standards for existing sources.

Except as provided in 40 CFR 403.7 and 403.13, any existing source subject to this subpart which introduces pollutants into a publicly owned treatment works must comply with 40 CFR part 403 and achieve the following pretreatment standards for existing sources. The mass of wastewater pollutants in secondary aluminum process wastewater introduced into a POTW shall not exceed the following values:

(a) Subpart C—Scrap Drying Wet Air Pollution Control.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum scrap dried	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(b) Subpart C—Scrap Screening and Milling.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum scrap screened and milled	
Lead .....	.000	.000

PSES—Continued

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(c) Subpart C—Dross Washing.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of dross washed	
Lead	3.043	1.413
Zinc	11.090	4.565
Ammonia (as N)	1,449.000	636.000

(d) Subpart C—Demagging Wet Air Pollution Control.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum demagged	
Lead	0.216	0.100
Zinc	0.786	0.324
Ammonia (as N)	102.800	45.180

(e) Subpart C—Delacquering Wet Air Pollution Control.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum delacquered	
Lead	0.093	0.043
Zinc	0.340	0.140
Ammonia (as N)	44.389	19.514
Total phenolics (4-AAP) method) ¹	0.004	

¹ At the source.

(f) Subpart C—Direct Chill Casting Contact Cooling.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.372	.173
Zinc	1.356	.558
Ammonia (as N)	177.200	77.800

(g) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chlorine Demagging Wet Air Pollution Control is Not Practiced On-Site).

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum cast	
Lead	0.019	0.009
Zinc	0.088	0.028
Ammonia (as N)	8.931	3.926

(h) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chlorine Demagging Wet Air Pollution Control is Practiced On Site.)

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(i) Subpart C—Stationary Casting Contact Cooling.

PSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(j) Subpart C—Shot Casting Contact Cooling.

Environmental Protection Agency

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PSSES

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

[49 FR 8796, Mar. 8, 1984, as amended at 49 FR 29794, July 24, 1984; 52 FR 25560, July 7, 1987]

§ 421.36 Pretreatment standards for new sources.

Except as provided in 40 CFR 403.7, any new source subject to this subpart which introduces pollutants into a publicly owned treatment works must comply with 40 CFR part 403 and achieve the following pretreatment standards for new sources. The mass of wastewater pollutants introduced in secondary aluminum process wastewater into a POTW shall not exceed the following values:

(a) Subpart C—Scrap Drying Wet Air Pollution Control.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum scrap dried	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(b) Subpart C—Scrap Screening and Milling.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum scrap screened and milled	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(c) Subpart C—Dross Washing.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of dross washed	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(d) Subpart C—Demagging Wet Air Pollution Control.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum demagged	
Lead	0.216	0.100
Zinc	0.786	0.324
Ammonia (as N)	102.800	45.180

(e) Subpart C—Delacquering Wet Air Pollution Control

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum delacquered	
Lead	0.093	0.043
Zinc	0.340	0.140
Ammonia (as N)	44.389	19.514
Total phenolics (4-AAP method) ¹	0.004	

¹ At the source.

(f) Subpart C—Direct Chill Casting Contact Cooling.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.372	.173
Zinc	1.356	.558
Ammonia (as N)	177.200	77.880

(g) Subpart C—Ingot Conveyor Casting Control Cooling (When Chlorine Demagging Wet Air Pollution Control is Not Practiced On-Site).

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PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (lb/million lbs) of aluminum cast	
Lead	0.019	0.009
Zinc	0.068	0.028
Ammonia (as N)	8.931	3.926

(h) Subpart C—Ingot Conveyor Casting Contact Cooling (When Chlorine Demagging Wet Air Pollution Control Is Practiced on Site).

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(i) Subpart C—Stationary Casting Contact Cooling.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

(j) Subpart C—Shot Casting Contact Cooling.

PSNS

Pollutant or pollutant property	Maximum for any 1 day	Maximum for monthly average
	mg/kg (pounds per million pounds) of aluminum cast	
Lead .....	.000	.000
Zinc .....	.000	.000
Ammonia (as N) .....	.000	.000

[49 FR 8796, Mar. 8, 1984, as amended at 49 FR 29794, July 24, 1984; 52 FR 25560, July 7, 1987]

40 CFR Ch. I (7-1-96 Edition)

§ 421.37 [Reserved]

Subpart D—Primary Copper Smelting Subcategory

SOURCE: 49 FR 8800, Mar. 8, 1984, unless otherwise noted.

§ 421.40 Applicability: Description of the primary copper smelting subcategory.

The provisions of this subpart apply to process wastewater discharges resulting from the primary smelting of copper from ore or ore concentrates. Primary copper smelting includes, but is not limited to, roasting, converting, leaching if preceded by a pyrometallurgical step, slag granulation and dumping, fire refining, and the casting of products from these operations.

§ 421.41 Specialized definitions.

For the purpose of this subpart:

(a) Except as provided below, the general definitions, abbreviations, and methods of analysis set forth in 40 CFR part 401 apply to this subpart.

(b) In the event that the waste streams covered by this subpart are combined for treatment or discharge with waste streams covered by Subparts E—Primary Electrolytic Copper Refining and/or Subpart I—Metallurgical Acid Plants, the quantity of each pollutant or pollutant property discharged shall not exceed the quantity of each pollutant or pollutant property which could be discharged if each waste stream were discharged separately.

(c) For all impoundments constructed prior to the effective date of the interim final regulation (40 FR 8513), the term "within the impoundment," when used to calculate the volume of process wastewater which may be discharged, means the water surface area within the impoundment at maximum capacity plus the surface area of the inside and outside slopes of the impoundment dam as well as the surface area between the outside edge of the impoundment dam and any seepage ditch adjacent to the dam upon which rain falls and is returned to the impoundment. For the purpose of such calculations, the surface area allowances set forth above shall not exceed

"Identification and Listing of Hazardous Waste "

NARA (National Archives and Records Administration). 1997. Code of Federal Regulations, Title 40: Protection of Environment, Part 261: Identification and Listing of Hazardous Waste, Subpart D, Item 261.32 (Washington D.C. Government Printing Office).

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

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TITLE 40--PROTECTION OF ENVIRONMENT

CHAPTER I--ENVIRONMENTAL PROTECTION AGENCY (CONTINUED)

PART 261--IDENTIFICATION AND LISTING OF HAZARDOUS WASTE--Table of Contents

Subpart D--Lists of Hazardous Wastes

Sec. 261.32 Hazardous wastes from specific sources.Secs.

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
WAIS Document Retrieval (p55 of 509)		
Primary aluminum:		
K088.....	Spent potliners from primary aluminum reduction.	(T)

WAIS Document Retrieval (p125 of 509)
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Appendix VII to Part 261--Basis for Listing Hazardous Waste

EPA hazardous waste No.	Hazardous constituents for which listed
WAIS Document Retrieval (p139 of 509)	
K088.....	Cyanide (complexes).

" Metal Molding and Casting Point Source Category "

NARA (National Archives and Records Administration). 1997. Code of Federal Regulations, Title 40: Protection of Environment, Part 464: Metal Molding and Casting Point Source Category, Subpart A, Item 464.10 (Washington D.C. Government Printing Office).

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
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TSDF #47-559

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TITLE 40--PROTECTION OF ENVIRONMENT

CHAPTER I--ENVIRONMENTAL PROTECTION AGENCY (Continued)

PART 464--METAL MOLDING AND CASTING POINT SOURCE CATEGORY--Table of Contents

Subpart A--Aluminum Casting Subcategory

Sec. 464.10 Applicability; description of the aluminum casting subcategory.
The provisions of this subpart are applicable to discharges to waters of the United States and to the introduction of pollutants into publicly owned treatment works resulting from aluminum casting operations as defined in Sec. 464.02(a).

" Standard Classification for Nonferrous Scrap Metals. "

NARI. 1973. Standard Classification for Nonferrous Scrap Metals. National Association of Recycling Industries, Inc., Circular NF-73, April 1. pgs 1-8.

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TSDF #47-559



National Association of
Recycling Industries, Inc.

Classification for Nonferrous Scrap Metals

CIRCULAR NF-73



Official Copies of this Classification always carry the Association's Seal

EFFECTIVE AS OF APRIL 1, 1973

Issued from
ASSOCIATION HEADQUARTERS
330 Madison Avenue, New York, N. Y. 10017

CODE WORD ITEM

Apple 1.—DELIVERY

- a. Delivery of more or less on the specified quantity up to 1¼ per cent is permissible.
- b. If the term "about" is used, it is understood that 5 per cent more or less of the quantity may be delivered.
- c. Should the seller fail to make deliveries as specified in the contract the purchaser has the option of cancelling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver and if unable to agree on the amount of damages, an Arbitration Committee of the National Association of Secondary Material Industries, Inc. may be appointed for this purpose, to determine the amount of such damages.
- d. In the event that buyer should claim the goods, delivered on a contract, are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute may be referred to an Arbitration Committee of the National Association of Secondary Material Industries, Inc. to be appointed for that purpose.
- e. A carload, unless otherwise designated, shall consist of the weight governing the minimum carload weight at the lowest carload rate of freight in the territory in which the seller is located. If destination of material requires a greater carload minimum weight, buyer must so specify.
- f. A ton shall be understood to be 2,000 pounds unless otherwise specified. On material purchased for export shipment a ton shall be specified as either a Gross Ton of 2240 lbs., or a Metric Ton of 2204.6 lbs.
- g. If, through embargo, a delivery cannot be made at the time specified, the contract shall remain valid, and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed. When shipments for export for which space has been engaged have been delivered or tendered to a steamship for forwarding and through inadequacy of cargo space the steamship cannot accept the shipment, or where steamer is delayed in sailing beyond its scheduled time, shipment on the next steamer from the port of shipment shall be deemed a compliance with the contract as to time of shipment.
- h. In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn public weigher shall be employed and the party most in error must pay the costs of handling and reweighing.
- i. When material is such that it can be sorted by hand, consignees cannot reject the entire shipment if the percentage of rejection does not exceed 10 per cent. The disposition of the rejected material should then be arranged by negotiations; no replacement of the rejected material to be made.

Upon request of the shipper, rejections shall be returnable to the seller on domestic shipments within 10 days and on foreign shipments within 30 days from the time notice of rejection is received by them and provided government regulations permit such return. Seller to pay 1¢ per lb. on material rejected to cover cost of sorting and packing and seller to be responsible for freight both ways.

j. PACKAGES

Shall be good strong packages suitable for shipment and each package shall be plainly marked with separate shipping marks and numbers and with the gross and tare weights so that the packages may reach their destination and their weights can be easily checked.

Berry 2.—No. 1 COPPER WIRE

Shall consist of clean, untinned, uncoated, unalloyed copper wire and cable, not smaller than No. 16 B & S wire gauge, free of burnt wire which is brittle. Hydraulically briquetted copper subject to agreement.

Birch 3.—No. 2 COPPER WIRE

Shall consist of miscellaneous, unalloyed copper wire having a nominal 96% copper content (minimum 94%) as determined by electrolytic assay. Should be free of the following: Excessively leaded, tinned, soldered copper wire; brass and bronze wire; excessive oil content, iron, and non-metallics; copper wire from burning, containing insulation; hair wire; burnt wire which is brittle; and should be reasonably free of ash. Hydraulically briquetted copper wire subject to agreement.

CODE WORD ITEM

Candy 4.—No. 1

Shall consist of punching less than brittle; but briquetted.

Cliff 5.—No. 2

Shall consist of ing a nominal determined by following: Excess brasses and bronze metallics; copper tions or with sedimenting insulation; hair and should be reasonably copper subject to agreement.

Dream 6.—LIGHT COPPER

Shall consist of miscellaneous ing a nominal 92% copper determined by electrolytic assay. copper, gutters, downspouts, scrap. Should be free of copper clad; plating rack burning, containing insulators; refrigerator units; excessively leaded, tinned, bronzes; excessive oil, iron; be reasonably free of ash. Hydraulically subject to agreement. Any items also excluded in the higher grade.

Drink 7.—REFINERY BRASS

Shall contain a minimum of 61.3% copper, 5% iron and to consist of brass and bronze turnings, and alloyed and contaminated copper scrap free of insulated wire, grindings, electrotypes, non-metallics. Hydraulically briquetted material subject to agreement.

Drove 8.—COPPER-BEARING SCRAP

Shall consist of miscellaneous copper-containing skimming, grindings, ashes, iron brass and copper, residues and sludge. Free of insulated wires; copper chlorides; unprepared tangled material; large motors; pyrophoric materials; asbestos brake linings; furnace bottoms; high lead materials; graphite crucibles; and noxious and explosive materials. Fine powdered material by agreement. Hydraulically briquetted material subject to agreement.

Ebony 9.—COMPOSITION OR RED BRASS

Shall consist of red brass scrap, valves, machinery bearings and other machinery parts, including miscellaneous castings made of copper, tin, zinc, and/or lead. Should be free of semi-red brass castings (78% to 81% copper); railroad car boxes and other similar high-lead alloys; cocks and faucets; gates; pot pieces; ingots and burned brass; aluminum and manganese bronzes; iron and non-metallics. No piece to measure more than 12" over any one part or weigh over 100 lbs.

Energ 10.—RED BRASS COMPOSITION TURNINGS

Shall consist of turnings from red brass composition material and should be sold subject to sample or analysis.

Eider 11.—GENUINE BABBITT-LINED BRASS BUSHINGS

Shall consist of red brass bushings and bearings from automobiles and other machinery, shall contain not less than 12% high tin base babbitt, and shall be free of iron-backed bearings.

Eland 12.—HIGH GRADE — LOW LEAD BRONZE SOLIDS

It is recommended these materials be sold by analysis.

Elbow 13.—BRONZE PAPER MILL WIRE CLOTH

Shall consist of clean genuine Fourdrinier wire cloth and screen having a minimum copper content of 87%, minimum tin content of 3%, and a maximum lead content of 1%, free of stainless steel and Monel metal stranding.

Elias 14.—HIGH LEAD BRONZE SOLIDS AND BORINGS

It is recommended that these materials be sold on sample or analysis.

BRASS SOLIDS

Shall consist of brass containing less than 75%, a tin content of not less than 10%, and not more than 0.75% impurities, exclusive of lead. Shall be free of scale.

BORINGS

Shall consist of brass containing less than 75%, a tin content of not less than 10%, and not more than 0.75% impurities, exclusive of lead. Shall be free of scale.

RAILROAD CAR BOXES

Shall consist of clean and/or sweated railroad car journal bearings, and railroad car boxes.

RAILROAD CAR BOXES

Shall consist of clean and/or sweated railroad car journal bearings, and railroad car boxes.

FAUCETS

Shall consist of clean red and yellow brass, including plated, free of gas cocks, beer faucets, zinc base die cast material, and to contain not more than 35% semi-red.

BRASS SCREENS

Shall consist of clean mixed-copper, brass and bronze screens, free of excessively dirty and painted material.

YELLOW BRASS SCRAP

Shall consist of brass castings, rolled brass, rod brass, tubing and miscellaneous yellow brasses, including plated brass. Must be free of manganese-bronze, aluminum-bronze, unsweated radiators or radiator parts, iron, excessively dirty and corroded materials.

2.—YELLOW BRASS CASTINGS

Shall consist of yellow brass castings in crucible shape, no piece to measure more than 12 inches over any one part; and shall be free of brass forgings, silicon bronze, aluminum bronze and manganese bronze, and not to contain more than 15% nickel plated material.

Knife 23.—OLD ROLLED BRASS

Shall consist of old pieces of yellow sheet brass and yellow light tubing brass, free from solder, tinned and nickel plated material, iron, paint and corrosion, rod brass and condenser tubes.

Label 24.—NEW BRASS CLIPPINGS

Shall consist of the cuttings of new unleaded yellow brass sheet or plate, to be clean and free from foreign substances and not to contain more than 10% of clean brass punchings under 1/4". To be free of Muntz metal and naval brass.

Lace 25.—BRASS SHELL CASES WITHOUT PRIMERS

Shall consist of clean fired 70/30 brass shell cases free of primers and any other foreign material.

Lady 26.—BRASS SHELL CASES WITH PRIMERS

Shall consist of clean fired 70/30 brass shell cases containing the brass primers and which contain no other foreign material.

Lake 27.—BRASS SMALL ARMS AND RIFLE SHELLS, CLEAN FIRED

Shall consist of clean fired 70/30 brass shells free of bullets, iron and any other foreign material.

Lamb 28.—BRASS SMALL ARMS AND RIFLE SHELLS, CLEAN MUFFLED (POPPED)

Shall consist of clean muffled (popped) 70/30 brass shells free of bullets, iron and any other foreign material.

Lark 29.—YELLOW BRASS PRIMER

Shall consist of clean yellow brass primers, burnt or unburnt. Free of iron, excessive dirt, corrosion and any other foreign material.

CODE WORD ITEM**Maize 30.—MIXED NEW NICKEL SILVER CLIPPINGS**

Shall consist of one or more nickel silver alloys and the range of nickel content to be specified, free of chrome or any other plating material. Leaded nickel silver clippings should be packed and sold separately. Not to contain more than 10% of clean punchings under 1/4 inch.

Major 31.—NEW NICKEL SILVER CLIPPINGS AND SOLIDS

Shall consist of new, clean nickel silver clippings, plate, rod and forgings, and other rolled shapes, free of chrome or any other plating material. Must be sold on nickel content specifications such as 10% — 12% — 15% — 18% — 20%. Leaded nickel silver clippings should be packed and sold separately. A description as to its physical characteristics should be made in offering all nickel silver material.

Malar 32.—NEW SEGREGATED NICKEL SILVER CLIPPINGS

Shall consist of one specified nickel silver alloy. Not to contain more than 10% of clean punchings under 1/4 inch.

Malic 33.—OLD NICKEL SILVER

Shall consist of Old Nickel Silver Sheet, Pipe, Rod, Tubes, Wire, Screen, soldered or unsoldered. Must not be trimmed seams alone and it is also to be free of foreign substances, iron rimmed material or other metals.

Melon 34.—BRASS PIPE

Shall consist of brass pipe free of plated and soldered materials or pipes with cast brass connections. To be sound, clean pipes free of sediment and condenser tubes.

Naggy 35.—NICKEL SILVER CASTINGS

To be packed and sold separately.

Niece 36.—NICKEL SILVER TURNINGS

To be sold by sample or analysis.

Night 37.—YELLOW BRASS ROD TURNINGS

Shall consist of strictly rod turnings, free of aluminum, manganese, composition, Tobin and Muntz metal turnings; not to contain over 3% free iron, oil or other moisture; to be free of grindings and babbitts; to contain not more than 0.30% tin and not more than 0.15% alloyed iron.

Noble 38.—NEW YELLOW BRASS ROD ENDS

Shall consist of new, clean rod ends from free turning brass rods or forging rods, not to contain more than 0.30% tin and not more than 0.15% alloyed iron. To be free of Muntz metal and naval brass or any other alloys. To be in pieces not larger than 12" and free of foreign matter.

Nomad 39.—YELLOW BRASS TURNINGS

Shall consist of yellow brass turnings, free of aluminum, manganese and composition turnings; not to contain over 3% of free iron, oil or other moisture; to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample or analysis.

Ocean 40.—MIXED UNSWEATED AUTO RADIATORS

Shall consist of mixed automobile radiators, to be free of aluminum radiators, and iron finned radiators. All radiators to be subject to deduction of actual iron. The tonnage specification should cover the gross weight of the radiators, unless otherwise specified.

Pales 41.—ADMIRALTY BRASS CONDENSER TUBES

Shall consist of clean sound Admiralty condenser tubing which may be plated or unplated, free of nickel alloy, aluminum alloy, and corroded material.

Pallu 42.—ALUMINUM BRASS CONDENSER TUBES

Shall consist of clean sound condenser tubing which may be plated or unplated, free of nickel alloy, and corroded material.

Palms 43.—MUNTZ METAL TUBES

Shall consist of clean sound Muntz metal tubing which may be plated or unplated, free of nickel alloy, aluminum alloy, and corroded material.

Pants 44.—PLATED ROLLED BRASS

Shall consist of plated brass sheet, pipe, tubing, and reflectors, free of soldered, tinned, corroded, and aluminum-painted material, Muntz metal and Admiralty tubing, and material with cast brass connections.

CODE WORD ITEM

Parch 45.—MANGANESE BRONZE SOLIDS

Shall have a copper content of not less than 55%, a lead content of not more than 1%, and shall be free of Aluminum bronze and Silicon bronze.

Racks 46.—SCRAP LEAD — SOFT

Shall consist of clean soft scrap lead, free of all foreign materials such as drosses, battery lead, lead covered cable, hard lead, collapsible tubes, foil, type metals, zinc, iron and brass fittings, dirty chemical lead. Free of radioactive materials.

Radio 47.—MIXED HARD/SOFT SCRAP LEAD

Shall consist of clean lead solids, free of foreign materials, such as drosses, battery lead, lead covered cable, collapsible tubes, type metals, zinc, iron and brass fittings, dirty chemical lead. Free of radioactive materials.

Rails 48.—BATTERY PLATES

If cells (plates, separators, and lugs) or battery plates, must be reasonably free of rubber. May be bought and sold by assay or as agreed between buyer and seller.

Rains 49.—DRAINED WHOLE BATTERIES

Batteries to be free of liquid and extraneous material content. Aircraft (aluminum or steel cased) and other special batteries subject to special agreement.

Rakes 50.—BATTERY LUGS

Shall be free from battery plates, rubber and foreign material. A minimum of 97% metallic content is required.

Ranks 51.—PEWTER

Shall consist of tableware and soda-fountain boxes but should contain a minimum of 84% tin. Siphon tops to be accounted for separately. Material must be free of brass, zinc, and other foreign metals.

Ranch 52.—BLOCK TIN

Block Tin must assay minimum of 98% tin, and to be free of liquids, solder, and brass connections, pewter, pumps, pot pieces, dirt.

Raves 53.—HIGH TIN BASE BABBITT

Shall contain a minimum of 78% tin and be free of brassy or zincy metals.

Relay 54.—LEAD COVERED COPPER CABLE

Free of armored covered cable, and foreign material.

Rents 55.—LEAD DROSS

Should be clean and reasonably free of foreign matter, iron, dirt, harmful chemicals or other metals. Free of radioactive materials. Assay basis, or as agreed between buyer and seller. Other metals present such as antimony, tin, etc. to be accounted for as agreed between buyer and seller.

Ropes 56.—LEAD WEIGHTS

May consist of lead balances with or without iron, as may be specified. Free of foreign materials.

Roses 57.—MIXED COMMON BABBITT

Shall consist of lead base bearing metal containing not less than 8% tin, free from Allens Metal, Ornamental, Antimonial and Type Metal. Must be free from all zincy and excessive copper in the alloy.

Saves 58.—OLD ZINC DIE CAST SCRAP

Shall consist of miscellaneous old zinc base die castings, with or without iron and other foreign attachments. Must be free of borings, turnings, dross pieces, chunks, melted pieces and skimmings. All unmeltables, dirt, foreign attachments, and volatile substances (such as rubber, cork, plastic, grease, etc.) are deductible. Material containing in excess of 30% iron will not constitute good delivery.

Scabs 59.—NEW ZINC DIE CAST SCRAP

Shall consist of new or unused, clean, zinc base die castings. Castings to be unplated, unpainted, and free from corrosion.

Scope 60.—NEW PLATED ZINC DIE CAST SCRAP

Shall consist of new or unused clean, plated zinc base die castings, free from corrosion.

CODE WORD ITEM

Scout 61.—ZINC DIE

Shall consist of motive grill attachments.

Score 62.—OLD

Shall consist of lids, clean borings and be excessive ments and ext

Screen 63.—NEW ZINC

Shall consist of from corrosion. ments. Printers zinc sheets and addresso ments. Printers zinc

Scull 64.—ZINC DIE CAST

Shall consist of melted smooth clean solid slabs drosses and to contain a maximum of 0. lead. Blocks are acceptable

Scribe 65.—CRUSHED CLEAN SCRAP DIE CAST SCRAP, AS MOBILE FRAGMENTIZERS

To be clean, free of dirt, oil, glass To contain a maximum of 5% iron, copper, aluminum and other

Scroll 66.—UNSORTED FRAGMENTIZERS

Material to contain 65% zinc-bearing glass, rubber, oil, iron and other unmeltable 5%. Quality to be determined by mutual agreement buyer and seller.

Scrub 67.—HOT DIP GALVANIZERS SLAB ZINC DROSS (Batch Process)

Shall consist only of galvanizers unsweated zinc slab form from hot dip galvanizing (Batch Process) minimum zinc content of 92% and shall be free of skimmings and tramp iron. Broken pieces under 2" in diameter shall not exceed 10% of the weight of each shipment. Slab shall not weigh over 100 pounds each. Material from continuous galvanizing operation is not acceptable. Blocks are acceptable upon mutual agreement.

Seal 68.—CONTINUOUS LINE GALVANIZING SLAB ZINC TOP DROSS.

Shall consist of unsweated zinc dross removed from the top of a continuous line galvanizing bath, in slab form not weighing in excess of 100 pounds each, with a minimum zinc content of 90%. Shall be free of skimmings. Broken pieces under 2" in diameter shall not exceed 10% of the weight of each shipment.

Seam 69.—CONTINUOUS LINE GALVANIZING SLAB ZINC BOTTOM DROSS

Shall consist of unsweated zinc dross removed from the bottom of a continuous line galvanizing bath, in slab form not weighing in excess of 100 pounds each, with a minimum zinc content of 92%. Shall be free of skimmings. Broken pieces under 2" in diameter shall not exceed 10% of the weight of each shipment.

Shelf 70.—PRIME ZINC DIE CAST DROSS

Shall consist of metal skimmed from the top of pot of molten zinc die cast metal. Must be unsweated, unfluxed, shiny, smooth, metallic and free from corrosion or oxidation. Should be poured in molds or in small mounds weighing not over 75 pounds each. Zinc shall be minimum of 85%.

ANY OTHER GRADES OF ZINC-BEARING MATERIALS NOT MENTIONED ARE SUBJECT TO SPECIAL ARRANGEMENT.

Table 71.—NEW PURE ALUMINUM CLIPPINGS

Shall consist of new, clean, unalloyed sheet, clippings and/or aluminum sheet cuttings, free from oil and grease, foil and any other foreign substances and from punchings less than 1/2" in size.

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Taboo 72.—MIXED LOW COPPER ALUMINUM CLIPPINGS AND SOLIDS

Shall consist of new, clean, uncoated and unpainted low copper aluminum scrap of two or more alloys and to be free of foil, hair wire, wire screen, dirt, and other foreign substances. Grease and oil not to total more than 1%. Also free from punchings less than 1/2" in size. New can stock subject to arrangement between buyer and seller.

Tabor 73.—MIXED OLD ALLOY SHEET ALUMINUM

Shall consist of clean old alloy sheet aluminum of two or more alloys and to be free of 70S series, foil, venetian blinds, castings, hair wire, screen wire, food or beverage containers, pie plates, dirt, and other foreign substances. Oil and grease not to total more than 1%. Up to 10% painted sidings and awnings permitted.

Taint 74.—SCRAP SHEET AND SHEET UTENSIL ALUMINUM

Shall consist of clean, unpainted old 2S or 3S aluminum sheet and sheet utensils, free from hub caps, radiator shells, airplane sheet, foil, food or beverage containers, pie plates, oil cans and bottle caps, dirt, and other foreign substances. Oil and grease not to total more than 1%.

Take 75.—NEW ALUMINUM CAN STOCK

Shall consist of new low copper aluminum can stock and clippings, clean, lithographed or not lithographed, and coated with clear lacquer but free of lids with sealers, iron, dirt and other foreign contamination. Oil not to exceed 1%.

Talc 76.—OLD CAN STOCK

Shall consist of clean old aluminum cans, decorated or clear, free of iron, dirt, liquid and/or other foreign contamination.

Tale 77.—PAINTED SIDING

Shall consist of clean, low copper aluminum siding scrap, painted one or two sides, free of iron, dirt, corrosion, fiber backing or other types of foreign contamination.

Talent 78.—COATED SCRAP

Shall consist of awnings, venetian blinds, vinyl, plastic, etc. Shall be subject to special arrangements between buyers and sellers.

Talk 79.—ALUMINUM COPPER RADIATORS

Shall consist of clean aluminum and copper radiators, and/or aluminum fins on copper tubing, free of brass tubing, iron and other foreign contamination.

Tall 80.—E. C. ALUMINUM NODULES

Shall consist of clean E. C. aluminum, chopped or shredded, free of screening, hair-wire, iron, insulation, copper and other foreign contamination. Must be free of minus 20 mesh material. Must contain 99.45% aluminum content.

Talon 81.—NEW PURE ALUMINUM WIRE AND CABLE

Shall consist of new, clean, unalloyed aluminum wire or cable free from hair wire, wire screen, iron, insulation and any other foreign substance.

Taste 82.—OLD PURE ALUMINUM WIRE AND CABLE

Shall consist of old, unalloyed aluminum wire or cable containing not over 1% free oxide or dirt and free from hair wire, wire screen, iron, insulation and any other foreign substance.

Tarry 83.—ALUMINUM PISTONS**(a) Clean Aluminum Pistons**

Shall consist of clean aluminum pistons to be free from struts, bushings, shafts, iron rings and any other foreign materials. Oil and grease not to exceed 2%.

(b) Aluminum Pistons with Struts

Shall consist of clean whole aluminum pistons with struts to be free from bushings, shafts, iron rings and any other foreign materials. Oil and grease not to exceed 2%.

(c) Irony Aluminum Pistons

Should be sold on recovery basis, or by special arrangements with purchaser.

CODE WORD ITEM

Teens 84.—SEGREGATED ALUMINUM BORINGS AND TURNINGS

Shall consist of clean, uncorroded aluminum borings and turnings of one specified alloy only and subject to deductions for fines in excess of 3% through a 20 mesh screen and dirt, free iron, oil, moisture and all other foreign materials. Material containing iron in excess of 10% and/or free magnesium or stainless steel or containing highly flammable cutting compounds will not constitute good delivery.

Telic 85.—MIXED ALUMINUM BORINGS AND TURNINGS

Shall consist of clean, uncorroded aluminum borings and turnings of two or more alloys and subject to deductions for fines in excess of 3% through a 20 mesh screen and dirt, free iron, oil, moisture and all other foreign materials. Material containing iron in excess of 10% and/or free magnesium or stainless steel or containing highly flammable cutting compounds will not constitute good delivery. To avoid dispute should be sold on basis of definite maximum zinc, tin and magnesium content.

Tense 86.—MIXED ALUMINUM CASTINGS

Shall consist of all clean aluminum castings which may contain auto and airplane castings but no ingots, and to be free of iron, dirt, brass, babbitt and any other foreign materials. Oil and grease not to total more than 2%.

Tepid 87.—WRECKED AIRPLANE SHEET ALUMINUM

Should be sold on recovery basis or by special arrangements with purchaser.

Terse 88.—NEW ALUMINUM FOIL

Shall consist of clean, new, pure, uncoated, unalloyed aluminum foil, free from anodized foil, radar foil and chaff, paper, plastics, or any other foreign materials. Hydraulically briquetted material by arrangement only.

Testy 89.—OLD ALUMINUM FOIL

Shall consist of clean, old, pure, uncoated, unalloyed aluminum foil, free from anodized foil, radar foil and chaff, paper, plastics, or any other foreign materials. Hydraulically briquetted material by arrangement only.

Thigh 90.—ALUMINUM GRINDINGS

Should be sold on recovery basis or by special arrangements with purchaser.

Thirl 91.—ALUMINUM DROSSES, SPATTERS, SPILLINGS, SKIMMINGS AND SWEEPINGS

Should be sold on recovery basis or by special arrangements with purchaser.

Throb 92.—SWEATED ALUMINUM

Shall consist of aluminum scrap which has been sweated or melted into a form or shape such as an ingot, pig or slab for convenience in shipping; to be free from corrosion, drosses or any foreign materials. Should be sold subject to sample or analysis.

Tooth 93.—SEGREGATED NEW ALUMINUM ALLOY CLIPPINGS AND SOLIDS

Shall consist of new, clean, uncoated and unpainted aluminum scrap of one specified aluminum alloy only and to be free of foil, hair wire, wire screen, dirt, and other foreign substances. Oil and grease not to total more than 1%. Also free from punchings less than 1/2" in size. New can stock subject to arrangement between buyer and seller.

Tough 94.—MIXED NEW ALUMINUM ALLOY CLIPPINGS AND SOLIDS

Shall consist of new, clean, uncoated and unpainted aluminum scrap of two or more alloys free of 70S series and to be free of foil, hair wire, wire screen, dirt, and other foreign substances. Oil and grease not to total more than 1%. Also free from punchings less than 1/2" in size. New Can Stock subject to arrangement between buyer and seller.

Tread 95.—SEGREGATED NEW ALUMINUM CASTINGS, FORGINGS AND EXTRUSIONS

Shall consist of new, clean, uncoated aluminum castings, forgings, and extrusions of one specified alloy only and to be free from sawings, stainless steel, zinc, iron, dirt, oil, grease and other foreign substances.

CODE WORD ITEM

Trump 96.—ALUMINUM AUTO CASTINGS

Shall consist of all clean automobile aluminum castings of sufficient size to be readily identified and to be free from iron, dirt, brass, babbitt bushings, brass bushings, and any other foreign materials. Oil and grease not to total more than 2%.

Twist 97.—ALUMINUM AIRPLANE CASTINGS

Shall consist of clean aluminum castings from airplanes and to be free from iron, dirt, brass, babbitt, bushings, brass bushings, and any other foreign materials. Oil and grease not to total more than 2%.

**ITEMS NOT COVERED SPECIFICALLY IN ALUMINUM
SCRAP SPECIFICATIONS SHOULD BE DISCUSSED
AND SOLD BY SPECIAL ARRANGEMENTS
BETWEEN BUYER AND SELLER.**

Aroma 98.—NEW NICKEL SCRAP

Shall consist of clean new sheet, plate, bar, tube, and any other wrought nickel scrap solids. Nickel minimum 99%. Free of castings, as well as any foreign attachments or other contamination.

Burly 99.—OLD NICKEL SCRAP

Shall consist of old and/or new sheet, plate, bar, tube, and any other wrought nickel scrap solids. Material to contain a minimum of 98% nickel. This grade to be free of castings, soldered, brazed, sweated, or painted material, other metallic coating, foreign attachments, and any other contamination.

Cache 100.—MISCELLANEOUS TYPES OF NICKEL SCRAP

Shall consist of miscellaneous types of nickel scrap, such as carbonized scrap, castings, strippings, peelings, baskets, and/or turnings. Particulars regarding physical description, assay, and packaging to be agreed on between buyer and seller.

Dandy 101.—NEW CUPRO NICKEL CLIPS AND SOLIDS

Shall consist of clean, new, segregated (normally accepted analysis grades) either 70/30, 80/20, or 90/10 cupro nickel tube, pipe, sheet, plate, or other wrought solid forms. Must be free of foreign attachments or any other contamination.

Daunt 102.—CUPRO NICKEL SOLIDS

Shall consist of old, and/or new, segregated (normally accepted analysis grades) either 70/30, 80/20, or 90/10 cupro nickel tube, pipe, sheet, plate, or other wrought solid forms. Maximum 2% sediment allowable. Any other forms of cupro nickel solids such as castings, gates, risers, spills, etc., packaged separately, may or may not be included, only upon agreement between buyer and seller. Must be free of foreign attachments and all other contamination. Other particulars concerning physical description, analysis and packaging to be agreed upon between buyer and seller.

Delta 103.—SOLDERED CUPRO NICKEL SOLIDS

Shall consist of segregated (normally accepted analysis grades) either 70/30, 80/20, or 90/10 cupro nickel solids, soldered, brazed, or sweated, must be free of trimmed seams and edges and all other contamination.

Decoy 104.—CUPRO NICKEL SPINNINGS, TURNINGS, BORINGS

Shall consist of clean segregated (normally accepted analysis grades) either 70/30, 80/20, or 90/10 cupro nickel spinings, turnings, or borings. Particulars concerning physical description, analysis, packaging, to be agreed upon between buyer and seller.

Hitch 105.—NEW MONEL CLIPPINGS AND SOLIDS

Shall consist of clean, new, Regular and/or R-Monel sheet, plate, bar, rod, tube, pipe, or any other wrought scrap, free of any foreign attachments or any other contamination.

Ideal 106.—OLD MONEL SHEET AND SOLIDS

Shall consist of new and/or old clean Regular and/or R-Monel sheet, pipe, plate, rod, and all other wrought scrap solids. Must be free of foreign attachments or any other contamination. (To exclude soldered, brazed, and unclean sweated material.)

CODE WORD ITEM

Indian 107.—K-MONEL RODS AND OTHER SOLIDS

Shall consist of clean K-Monel rods and other solids.

Junto 108.—SOLDERED MONEL SHEET AND SOLIDS

Shall consist of soldered and/or brazed, Regular or Miscellaneous grades of Monel Alloys (with basic minimum 63% Nickel contained in any alloy itself), in either wrought or cast form. Must be free of trimmed seams and edges, non-metallic filling, foreign attachments, and all other contamination. Particulars concerning physical description, assay, and packaging to be agreed upon between buyer and seller.

Lemon 109.—MONEL CASTINGS

Shall consist of various types of clean Monel castings, assaying minimum 60% nickel. Must be free of foreign attachments, or any other contamination.

Lemur 110.—MONEL TURNINGS

Shall consist of mixed Monel turnings and borings containing a minimum of 60% nickel content, on a dry basis.

Pekoe 111.—200 SERIES STAINLESS STEEL SCRAP SOLIDS

Shall consist of all types of clean AISI Series Stainless Steel Scrap Solids, which contain a maximum of .5% copper, free of foreign attachments and other contamination.

Sabot 112.—STAINLESS STEEL SCRAP

Shall consist of clean 18-8 type stainless steel clips and solids containing a minimum 7% nickel, 16% chrome, and have a maximum of .50% molybdenum, .5% copper, .045% phosphorous, and .03% sulfur, and otherwise free of harmful contaminants. Particulars concerning physical description, grading, additional analysis, and preparation to be agreed upon between buyer and seller.

Ultra 113.—STAINLESS STEEL TURNINGS

Shall consist of clean 18-8 type stainless steel turnings containing a minimum of 7% nickel and 16% chrome, and to be free of nonferrous metals, non-metallics, excessive iron, oil and other contaminants. Particulars concerning physical description, assay, packaging to be agreed upon between buyer and seller.

Rusten 114.—11-14% CHROME STAINLESS SCRAP

Straight chrome stainless scrap shall contain 11-14% chrome, phosphorous and sulphur .03% maximum, and shall not contain over .50% nickel and otherwise be free from harmful contaminants. Material to be prepared to individual consumer's specifications.

Rusthirty 115.—14-18% CHROME STAINLESS SCRAP

Straight chrome stainless scrap shall contain 14-18% chrome, phosphorous and sulphur .03% maximum, and shall not contain over .50% nickel and otherwise be free from harmful contaminants. Material to be prepared to individual consumer's specifications.

Vaunt 116.—EDISON BATTERIES

To be sold free of crates, copper terminal connectors, and drained free of excess liquid, to be free of type "B" batteries.

**ANY OTHER PARTICULARS IN THE NICKEL ALLOY
GROUP CONCERNING PHYSICAL DESCRIPTION,
ASSAY, AND PACKAGING TO BE AGREED UPON
BETWEEN BUYER AND SELLER.**

GENERAL NOTE

It has been the purpose in revising these specifications to provide for those materials which are most frequently dealt in. Any items for which classifications are not specified should be subject to negotiations between buyer and seller.

IDENTIFICATION CHECK LIST FOR PRECIOUS METALS

Because in the precious metals industry values are derived from the exact analysis obtained from a representative sample, it is not possible to develop a set of specifications similar to those NASMI has established for other nonferrous metals.

This Identification Check List, however, for the first time sets up a general basis for identifying types and grades of precious metal scrap by the scrap processor which will be familiar both to the precious metal refiner and to the plants generating precious metal scrap.

By checking this identification list, the scrap processor gives the refiner a fairly accurate conception of the material he has on hand and offers a basis for the refiner to quote an estimated price for the material.

Though this Identification Check List is added to NASMI's specification circular, it is to be cautioned that these are not specifications but are to be regarded as a guideline for scrap processors and refiners.

Due to the high value and the constantly changing character of precious metal scrap it is the practice in the industry to require a sample to be submitted before giving refining schedules.

I. SCRAP SOURCES

REFINED SILVER METAL—99.9 PLUS PERCENT

SILVER BEARING MATERIALS:

Anodes	Jewelry Sweeps
Assemblies—Electrical	Paints—Paste
Batteries	Paper—Reproduction
Silver/Copper	Plated Parts—Electrical—
Silver/Cadmium	Electronic
Silver/Zinc	Plated Serving Pieces
Silver/Magnesium	Plated Utensils
Blanking Scrap—Punchings	Plated Wire
Brazing Alloys	Powders—Granulated
Brushes—Electric Motors	Punchouts
Bullion	Relays—Electrical
Chemical Salts	Resins
Clad Bi-Metal Parts	Silver Lined Bearings—
Coin Silver	Diesel Locomotives
Contacts	and Aircraft
Dental Amalgam	Sludges—Plating and
Film	Precipitates
Industrial X-Ray	Solutions—Plating
Medical X-Ray	Sterling Silver
Lithographic	Tin Lead Alloys—
Photographic Negatives	Contaminated
Filters—Plating	Turnings
Flake—From Hypo Solution	Wave Guides
Recovery Systems	Wiping Rags
Hooks—Plating—Nodules	

REFINED GOLD METAL—99.9 PLUS PERCENT

REFINED GOLD SPONGE—99.9 PLUS PERCENT

GOLD BEARING MATERIALS:

Brazing Alloys	Placer Gold
Cladmetal Parts	Plated Parts—Electrical
Contacts	Plated Wire
Dental Alloys	Powders
Dental Scrap	Printed Circuit Boards
Dental Sweeps and	Printed Circuit Boards
Grindings	with Components
Diodes	Punchouts
Filled Scrap	Resins—Plating
Filters—Plating	Salts—Chemical
Flakes	Sludges—Plating
Flashings	Solutions
Foil	Sponge
Hooks—Plating—Nodules	Tin Lead Alloys—
Jewelry Scrap	Contaminated
Jewelry Sweeps and	Transistors
Grindings	Wiping Rags
Paints and Paste	Wire
Peelings	

REFINED PLATINUM METAL—99.9 PLUS PERCENT

REFINED PLATINUM SPONGE—99.8 PLUS PERCENT

PLATINUM BEARING MATERIALS:

Catalysts	Jewelry Sweeps
Chemicals	Laboratory Ware
Clad Materials	Magneto Points
Contacts	Powders and Paste
Dental Alloys	Solutions—Plating
Dental Scrap	Spark Plugs—Aircraft
Dental Sweeps, Grindings	Thermocouple Wire
Jewelry Scrap	

REFINED PALLADIUM METAL—99.8 PLUS PERCENT

REFINED PALLADIUM SPONGE—99.8 PLUS PERCENT

PALLADIUM BEARING MATERIALS:

Catalysts	Plated Parts
Clad Materials	Powders
Contact Points	Relays—Electrical
Dental Alloys	Salts—Chemical
Dental Scraps	Sludges
Dental Sweeps	Solutions
Jewelry Scrap (Sweeps)	Wire
Paste	

SCRAP CONTAINING COMBINATIONS OF PRECIOUS

METALS (GOLD, SILVER, PLATINUM AND PALLADIUM)

Assemblies—Components	Paints
Bullion	Relays—Electrical
Carbon	Resins
Catalysts	Ribbons
Chemicals	Rings
Chips	Salts
Drillings	Solutions
Electronic Scrap	Sweeps
High Temperature	Telephone Switching
Resistant Alloys	Scrap
Paste	Thick Film
Powders	Wire

II. SCRAP CATEGORIES

- | | |
|--|--|
| <p>A. Solution</p> <ol style="list-style-type: none"> 1. Acid 2. Basic 3. Matrix if known <p>B. Resin</p> <p>C. Sludges</p> <p>D. Burnable Material</p> <ol style="list-style-type: none"> 1. Carbon 2. Filters 3. Film 4. Papers 5. Unprepared Sweeps 6. Others <p>E. Sweeps (Prepared)</p> <p>F. Printed Circuit Boards</p> <ol style="list-style-type: none"> 1. Punch Outs 2. Non Assembled 3. Assembled 4. Other <p>G. Glass to metal Tubes, etc.</p> <ol style="list-style-type: none"> 1. Solid Precious Metal Parts 2. Alloyed Metal Parts 3. Plated Metal Parts 4. Ceramics 5. Thick Film 6. Other | <p>H. Metal Scrap</p> <p><i>I. Non Magnetic</i></p> <ol style="list-style-type: none"> 1. Impure Gold 2. Impure Silver 3. Copper Base 4. Aluminum Base 5. Brass Base 6. Bronze Base 7. Molybdenum Base 8. Beryllium Base 9. Lead Base 10. Tin Base 11. Other <p><i>II. Magnetic</i></p> <ol style="list-style-type: none"> 1. Kovar Base 2. Stainless Steel Base 3. Iron Base 4. Nickel Base 5. Other <p>I. Catalyst</p> <ol style="list-style-type: none"> 1. Carbon 2. Alumina 3. Rare Earth 4. Silica 5. Other |
|--|--|

(Continued on next page)

STANDARD CLASSIFICATION FOR NONFERROUS SCRAP METALS

IDENTIFICATION CHECK LIST FOR PRECIOUS METALS

(Continued)

CONDITION

A. Alloy
B. Mixture
C. Exposed
D. Poured
E. Soldered

F. Welded
G. Hidden
H. Inside
I. Surface
J. Clad

K. Filled
L. Plated
M. Casting
N. Other

IV. VOLUME

Weight lbs.

Volume gallons

PRECIOUS METALS CONTENT

	Gold	Silver	Platinum	Palladium	Rhodium	Ruthenium	Iridium	Base/Matrix
Precious Metal Est. % Content								
Trace 0.5%								
0.51 to 2.0%								
2.01 to 10.0								
10.01 to 20.0								
20.01 to 30.0								
30.01 to 40.0								
40.01 to 50.0								
50.01 to 60.0								
60.01 to 70.0								
70.01 to 80.0								
80.01 to 90.0								
90.01 to 95.0								
95.01 to 100.0								

" Standard Industrial Classification "

OMB. 1987. Standard Industrial Classification Manual. Executive Office of the President, Office of Management and Budget, pgs 146-8.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

Industry
Group
No.
286

Industry
No.

INDUSTRIAL ORGANIC CHEMICALS—Con.

2869 Industrial Organic Chemicals, Not Elsewhere Classified—Con.

Ethylene glycol
Ethylene glycol ether
Ethylene glycol, inhibited
Ethylene oxide
Ethylene, made in chemical plants
Fatty acid esters and amines
Ferric ammonium oxalate
Flavors and flavoring materials, synthetic
Fluorinated hydrocarbon gases
Formaldehyde (formalin)
Formic acid and metallic salts
Fuel propellants, solid: organic
Fuels, high energy: organic
Geraniol, synthetic
Glycerin, except from fats (synthetic)
Grain alcohol, industrial (nonbeverage)
Hexamethylenediamine
Hexamethylenetetramine
High purity grade chemicals, organic: refined from technical grades
Hydraulic fluids, synthetic base
Industrial organic cyclic compounds
Ionone
Isopropyl alcohol
Ketone, methyl ethyl
Ketone, methyl isobutyl
Laboratory chemicals, organic
Lauric acid esters
Lime citrate
Malononitrile, technical grade
Metallic salts of acyclic organic chemicals
Metallic stearate
Methanol, synthetic (methyl alcohol)
Methyl chloride
Methyl perhydrofluorine
Methyl salicylate
Methylamine
Methylene chloride
Monochlorodifluoromethane
Monomethylparaminophenol sulfate
Monosodium glutamate
Mustard gas
Naphthalene sulfonic acid condensates
Naphthenic acid soaps
Normal hexyl decalin
Nuclear fuels, organic
Oleic acid esters
Organic acid esters
Organic chemicals, acyclic
Oxalates
Oxalic acid and metallic salts
Pentaerythritol
Perchloroethylene

Perfume materials, synthetic
Phosgene
Phthalates
Plasticizers, organic: cyclic and acyclic
Polyhydric alcohol esters and amines
Polyhydric alcohols
Potassium bitartrate
Propellants for missiles, solid: organic
Propylene glycol
Propylene, made in chemical plants
Quinuclidinol ester of benzylic acid
Reagent grade chemicals, organic: refined from technical grades, except diagnostic and substances
Rocket engine fuel, organic
Rubber processing chemicals, organic: accelerators and antioxidants
Saccharin
Sebacic acid
Silicones
Sodium acetate
Sodium alginate
Sodium benzoate
Sodium glutamate
Sodium pentachlorophenate
Sodium sulfoxalate formaldehyde
Solvents, organic
Sorbitol
Stearic acid salts
Sulfonated naphthalene
Sweeteners, synthetic
Tackifiers, organic
Tannic acid
Tanning agents, synthetic organic
Tartaric acid and metallic salts
Tartrates
Tear gas
Terpineol
Tert-butylated bis (p-phenoxyphenyl) ether fluid
Tetrachloroethylene
Tetraethyl lead
Thioglycolic acid, for permanent wave lotions
Trichloroethylene
Trichlorophenoxyacetic acid
Trichlorotrifluoroethane tetrachlorodifluoroethane isopropyl alcohol
Tricresyl phosphate
Tridecyl alcohol
Trimethyltrithiophosphite (rocket propellants)
Triphenyl phosphate
Vanillin, synthetic
Vinyl acetate

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AGRICULTURAL CHEMICALS

This group includes establishments primarily engaged in manufacturing nitrogenous and phosphatic basic fertilizers, mixed fertilizers, pesticides, and other agricultural chemicals. Establishments primarily engaged in manufacturing basic chemicals, which require further processing or formulation before use as agricultural pest control agents, are classified in Industry Groups 281 or 286.

Industry
Group
No.
287

Industry
No.

2873

2874

2875

2879

Industry
Group
No.
287

Industry
No.

AGRICULTURAL CHEMICALS—Con.

2873 Nitrogenous Fertilizers

Establishments primarily engaged in manufacturing nitrogenous fertilizer materials or mixed fertilizers from nitrogenous materials produced in the same establishment. Included are ammonia fertilizer compounds and anhydrous ammonia, nitric acid, ammonium nitrate, ammonium sulfate and nitrogen solutions, urea, and natural organic fertilizers (except compost) and mixtures.

Ammonia liquor
Ammonium nitrate and sulfate
Anhydrous ammonia
Aqua ammonia, made in ammonia plants
Fertilizers, mixed: made in plants producing nitrogenous fertilizer materials

Fertilizers: natural (organic), except compost
Nitric acid
Nitrogen solutions (fertilizer)
Plant foods, mixed: made in plants producing nitrogenous fertilizer materials
Urea

2874 Phosphatic Fertilizers

Establishments primarily engaged in manufacturing phosphatic fertilizer materials, or mixed fertilizers from phosphatic materials produced in the same establishment. Included are phosphoric acid; normal, enriched, and concentrated superphosphates; ammonium phosphates; nitro-phosphates; and calcium meta-phosphates.

Ammonium phosphates
Calcium meta-phosphates
Defluorinated phosphates
Diammonium phosphates
Fertilizers, mixed: made in plants producing phosphatic fertilizer materials

Phosphoric acid
Plant foods, mixed: made in plants producing phosphatic fertilizer materials
Superphosphates, ammoniated and not ammoniated

2875 Fertilizers, Mixing Only

Establishments primarily engaged in mixing fertilizers from purchased fertilizer materials.

Compost
Fertilizers, mixed: made in plants not manufacturing fertilizer materials

Potting soil, mixed

2879 Pesticides and Agricultural Chemicals, Not Elsewhere Classified

Establishments primarily engaged in the formulation and preparation of ready-to-use agricultural and household pest control chemicals, including insecticides, fungicides, and herbicides, from technical chemicals or concentrates; and the production of concentrates which require further processing before use as agricultural pesticides. This industry also includes establishments primarily engaged in manufacturing or formulating agricultural chemicals, not elsewhere classified, such as minor or trace elements and soil conditioners. Establishments primarily engaged in manufacturing basic or technical agricultural pest control chemicals are classified in Industry Group 281 if the chemicals are inorganic and in Industry Group 286 if they are organic. Establishments primarily engaged in manufacturing agricultural lime products are classified in Major Group 32.

Agricultural disinfectants
Agricultural pesticides
Arsenates: calcium, copper, and lead-formulated

Arsenites, formulated
Bordeaux mixture
Calcium arsenate and arsenite, formulated

Industry
Group
No.Industry
No.

287

AGRICULTURAL CHEMICALS—Con.**2879 Pesticides and Agricultural Chemicals, Not Elsewhere Classified—Con.**

Cattle dips
Copper arsenate, formulated
DDT (insecticide), formulated
Defoliants
Elements, minor or trace (agricultural chemicals)
Exterminating products, for household and industrial use
Fly sprays
Fungicides
Growth regulants, agricultural
Herbicides
Household insecticides
Insect powder, household
Insecticides, agricultural
Lead arsenate, formulated
Lime-sulfur, dry and solution
Lindane, formulated
Moth repellants
Nicotine and salts

Nicotine bearing insecticides
Paris green (insecticide)
Pesticides, household
Phytoactin
Plant hormones
Poison: ant, rat, roach, and rodent—household
Pyrethrin bearing preparations
Pyrethrin concentrates
Rodenticides
Rotenone bearing preparations
Rotenone concentrates
Sheep dips, chemical
Sodium arsenite (formulated)
Soil conditioners
Sulfur dust (insecticide)
Thiocyanates, organic (formulated)
Trace elements (agricultural chemicals)
Xanthone (formulated)

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MISCELLANEOUS CHEMICAL PRODUCTS**2891 Adhesives and Sealants**

Establishments primarily engaged in manufacturing industrial and household adhesives, glues, caulking compounds, sealants, and linoleum, tile, and rubber cements from vegetable, animal, or synthetic plastics materials, purchased or produced in the same establishment. Establishments primarily engaged in manufacturing gelatin and sizes are classified in Industry 2899, and those manufacturing vegetable gelatin or agar-agar are classified in Industry 2833.

Adhesives
Adhesives, plastics
Caulking compounds
Cement (cellulose nitrate base)
Cement, linoleum
Cement, mending
Epoxy adhesives
Glue, except dental: animal, vegetable, fish, casein, and synthetic resin
Iron cement, household
Joint compounds

Laminating compounds
Mucilage
Paste, adhesive
Porcelain cement, household
Rubber cement
Sealing compounds for pipe threads and joints
Sealing compounds, synthetic rubber and plastics
Wax, sealing

2892 Explosives

Establishments primarily engaged in manufacturing explosives. Establishments primarily engaged in manufacturing ammunition for small arms are classified in Industry 3482, and those manufacturing fireworks are classified in Industry 2899.

Amatol (explosives)
Azides (explosives)
Blasting powder and blasting caps
Carbohydrates, nitrated (explosives)
Cordeau detonant (explosives)
Cordite (explosives)
Detonating caps for safety fuses
Detonators (explosive compounds)
Dynamite
Explosive cartridges for concussion forming of metal
Explosive compounds
Explosives
Fulminate of mercury (explosive compounds)

Fuse powder
Fuses, safety
Gunpowder
High explosives
Lead azide (explosives)
Mercury azide (explosives)
Nitrocellulose powder (explosives)
Nitroglycerin (explosives)
Nitromannitol (explosives)
Nitrostarch (explosives)
Nitrosugars (explosives)
Pentolite (explosives)
Permissible explosives
Picric acid (explosives)
Powder, explosive: pellet, smokeless,

Industry
Group
No.

289

" Bailment and Security Agreement "

SMS/MEC. 1980. Bailment and Security Agreement, Bailee-Debtor: Dan E. Johnson
(Smokey Mountain Smelters, Inc.), Bailor-Secured Party: Morris Lefton
(Metals Exchange Corporation), April 18.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

BAILMENT AND SECURITY AGREEMENT

THIS AGREEMENT, made this 18th day of April, 1980, by and between METAL EXCHANGE CORPORATION, a Missouri corporation with offices at 111 West Port Plaza, Suite 704, St. Louis, Missouri 63141, (hereinafter referred to as the "Bailor-Secured Party"), and Smokey Mountain Smelters, Inc., with offices at P.O. Box 2704; Knoxville, Tennessee 37901, (hereinafter referred to as the "Bailee-Debtor"),

WHEREAS, the parties are mutually desirous of maintaining a business relationship in which the Bailor-Secured Party may from time to time deliver materials and goods, including but not limited to aluminum pot bottoms, to the Bailee-Debtor, for the purpose of processing such materials into aluminum sow, and

WHEREAS, it is the desire and intention of the parties that such materials and goods and all products, final or intermediate, made therefrom, shall remain at all times the exclusive property of the Bailor-Secured Party,

NOW, THEREFORE, for and in consideration of the mutual promises, covenants and agreements herein contained, the parties hereto do mutually agree as follows:

1. Processing. Bailee-Debtor hereby agrees to (a) accept such aluminum pot bottoms, or other similar materials, as Bailor-Secured Party, may from time to time so deliver, and (b) process such aluminum pot bottoms into aluminum sow.
2. Bailee-Debtor's Duty to Keep Bailor-Secured Party's Materials and Goods Separate. Whenever the Bailor-Secured Party shall deliver any of its materials or goods to the Bailee-Debtor or any of the Bailee-Debtor's agents, for processing, manufacturing or alteration, Bailee-Debtor or such agent shall maintain the

physical identity of such materials or goods at all times by tagging, records or other appropriate means and shall not mix or commingle the Bailor-Secured Party's materials with any other materials or goods, and the same materials or goods will be redelivered to the Bailor-Secured Party after processing, manufacturing or alteration. However, in the case of fungible goods, whenever it would be impossible or impracticable to store, process or alter such goods without mixing and commingling the Bailor-Secured Party's materials and goods with other identical materials or goods, such commingling shall be permitted. After the Bailor-Secured Party's goods or materials have been so mixed or commingled the portion of the resulting mass or mixture representing the Bailor-Secured Party's materials or goods shall then be isolated and separated from such a mass or mixture at the earliest practical time and the physical identity of such isolated materials or goods shall again be maintained as the Bailor-Secured Party's sole property.

3. Risk of Loss. The Bailee-Debtor agrees to bear the risk of loss of any of Bailor-Secured Party's materials or goods in their individual possession in addition to any other risk of loss as may be otherwise allocated to them by law or express agreement.

on a schedule provided by Bailee-Debtor to Bailor-Secured Party.

4. Right of Possession of Bailor-Secured Party's Materials and Goods. In the event of (a) failure to comply with the provisions of this Agreement, (b) failure to comply with the provisions of any other agreement with respect to the Bailor-Secured Party's materials or goods, (c) any loss, theft, substantial damage or destruction of the Bailor-Secured Party's materials or goods or issuance of attachment, levy, garnishment or judicial process with respect to the Bailor-Secured Party's materials or goods, (d) insolvency, bankruptcy, business failure, assignment for the benefit of creditors or appointment of a receiver for the Bailee-Debtor or Bailor-Secured Party deeming itself insecure, believing in good faith that the prospect of performance of this Agreement or the return of its materials or goods is impaired, the Bailor-Secured Party shall have the right, with or without demand first made, and with or without legal process, immediately to take possession of the Bailor-Secured Party's materials or goods entrusted to the Bailee-Debtor's possession or a portion of a commingled mass of goods or materials representing Bailor-Secured Party's goods, wherever the same may be found, using reasonable force if necessary, and the Bailee-Debtor waives all claims for damages due to or arising from or connected with any such undertaking. Where the Bailor-Secured Party is unable to repossess the materials or goods peaceably, an action at law or in equity for the possession thereof will lie.

5. Security Interest. Except in cases in which Bailor-Secured Party has transferred title and ownership to materials by specific documents which expressly transfer such title and ownership, it shall be presumed that the title to and ownership of any materials and goods delivered by the Bailor-Secured Party to the Bailee-Debtor shall remain in the Bailor-Secured Party. However, in the event the parties shall enter into any transaction such that title and/or ownership, as opposed to temporary possession

rights, of materials or goods shall pass from the Bailor-Secured Party to the Bailee-Debtor, then the Bailee-Debtor hereby grants a security interest in any such materials or goods, to secure payment of the purchase price and/or performance of all obligations in connection with such transaction. In the event of (a) failure to comply with the provisions of this or any other agreement, (b) failure to pay when due any portion of indebtedness, including interest, (c) any loss, theft, substantial damage or destruction of the collateral or issuance of attachment, levy, garnishment or judicial process with respect to the collateral, (d) insolvency, bankruptcy, business failure, assignment for the benefit of creditors or appointment of a receiver for the Bailee-Debtor or any of its property or Bailor-Secured Party, deeming itself insecure, believing in good faith that prospect of payment of indebtedness or performance of this Agreement is impaired, the Bailor-Secured Party, at its election and without prior notice may declare all obligations immediately due and payable and shall have all the remedies of a secured party. The filing of a financing statement with respect to any transaction shall not be considered as any evidence that the parties consider such a transaction a sale rather than a bailment for processing.

IN WITNESS WHEREOF, the parties have executed this Agreement as of the day and year first above written.

METAL EXCHANGE CORPORATION

By

[Signature]
Bailor-Secured Party
Smokey Mountain Smelters, Inc.

By

[Signature]
Bailee-Debtor

" Uniform Commercial Code -Financing Statement "

STN. 1980. State of Tennessee, Uniform Commercial Code-Financing Statement-
Form UCC-1, Debtor: Smokey Mountain Smelters, Inc., Secured Party:
Metal Exchange Corporation, April 18.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

STATE OF TENNESSEE

UNIFORM COMMERCIAL CODE—FINANCING STATEMENT—FORM UCC-1

INSTRUCTIONS

- PLEASE TYPE this form. Fold only along perforation for mailing.
Remove Secured Party and Debtor copies and send other 3 copies with interleaved carbon paper to the filing officer. Enclose filing fee of \$2.50.
When filing is to be with more than one office, Form 2 may be placed over this set to avoid double typing.
- If the space provided for any item(s) on the form is inadequate the item(s) should be continued on additional sheets, preferably 5" x 8" or 8" x 10".
- Only one copy of such additional sheets need be presented to the filing officer with a set of three copies of the financing statement. Long schedules of collateral, indentures, etc., may be on any size paper that is convenient for the secured party.
- If collateral is crops or goods which are or are to become fixtures, describe generally the real estate and give name of record owner.
- When a copy of the security agreement is used as a financing statement, it is requested that it be accompanied by a completed but unsigned set of these forms, without extra fee.
- At the time of original filing, filing officer should return third copy as an acknowledgment. At a later time, secured party may date and sign Termination Legend and use third copy as a Termination Statement.

This FINANCING STATEMENT is presented to a filing officer for filing pursuant to the Uniform Commercial Code:

3 Maturity date (if any):

1 Debtor(s) (Last Name First) and address(es)

Smokey Mountain Smelters, Inc.
P.O. Box 2704
Knoxville, Tennessee 37901

2 Secured Party(ies) and address(es)

Metal Exchange Corporation
111 West Port Plaza,
Suite 704
St. Louis, Mo. 63141

For Filing Officer (Date, Time, Number, and Filing Office)

4 This financing statement covers the following types (or items) of property:

Aluminum pot bottoms and similar materials. (This statement is for informational purposes only. Secured Party is the owner of all such items insofar as Debtor is merely a bailee and has no rights in such materials or the proceeds or products thereof except as a bailee.)

ASSIGNEE OF SECURED PARTY

Check ☒ If covered: ☒ Proceeds of Collateral are also covered ☒ Products of Collateral are also covered No. of additional Sheets presented:

Filed with:

Smokey Mountain Smelters, Inc.

Metal Exchange Corporation

By:

Signature(s) Debtor(s)

By:

Signature(s) of Secured Party(ies)

(1) Filing Officer Copy—Alphabetical

STATE OF TENNESSEE

UNIFORM COMMERCIAL CODE—FINANCING STATEMENT—FORM UCC-1

INSTRUCTIONS

1. PLEASE TYPE this form. Fold only along perforation for mailing.
2. Remove Secured Party and Debtor copies and send other 3 copies with interleaved carbon paper to the filing officer. Enclose filing fee of \$2.50.
3. When filing is to be with more than one office, Form 2 may be placed over this set to avoid double typing.
4. If the space provided for any item(s) on the form is inadequate, the item(s) should be continued on additional sheets, preferably 5" x 8" or 8" x 10". Only one copy of such additional sheets need be presented to the filing officer, with a set of three copies of the financing statement. Long schedules of collateral, indentures, etc., may be on any size paper that is convenient for the secured party.
5. If collateral is crops or goods which are or are to become fixtures, describe separately the real estate and give name of record owner.
6. When a copy of the security agreement is used as a financing statement, it is requested that it be accompanied by a completed but unsigned set of these forms, without extra fee.

At the time of original filing, filing officer should return third copy as an acknowledgment. At a later time, secured party may date and sign Termination Legend and use third copy as a Termination Statement.

This FINANCING STATEMENT is presented to the filing officer for filing pursuant to the Uniform Commercial Code.

3. Maturity date (if any):

1 Debtor(s) (Last Name First) and address(es):

Smokey Mountain Smelters, Inc.
P.O. Box 2704
Knoxville, Tennessee 37901

2 Secured Party (last name and address(es)):

Metal Exchange Corporation
111 West Port Plaza, Ste. 200
St. Louis, MO 63141

File Filing Officer (Date, Time, Number, and Office):

4 This financing statement covers the following type(s) of property:

Aluminum pot Bottoms and similar materials. (This statement is for informational purposes only. Secured Party is the owner of all such items insofar as Debtor is merely a bailee and has no rights in such materials or the proceeds or products thereof except as a bailee.)

ASSIGNMENT OF SECURED PARTY

Check ☒ if covered: ☒ Property of Collateral are also covered: ☒ Products of Collateral are also covered No. of additional Sheets presented

2 Filed with:

Smokey Mountain Smelters, Inc.

Metal Exchange Corporation

Signature(s) of Debtor(s)

By:

Signature(s) of Secured Party (ies)

(1) Filing Officer Copy—Alphabetical

" Ground-Water Resources of East Tennessee "

TDC/Division of Geology (DG). 1956. "Ground-Water Resources of East Tennessee". State of Tennessee, Department of Conservation, Division of Geology. Bulletin 58, Part 1, pp. 6-9, 12, 43-4, 245-68, Plate 9 (See Figure 5, "GEOLOGIC MAP").

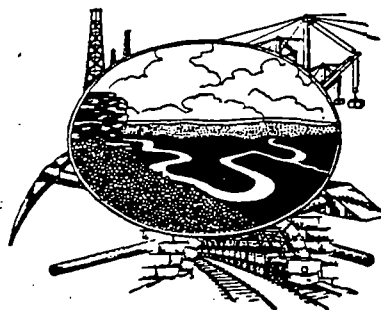
SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
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BULLETIN 58
PART I

GROUND-WATER RESOURCES OF
EAST TENNESSEE

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GEOGRAPHY

Physiographic Divisions

East Tennessee lies within the boundaries of three great physiographic divisions. These divisions, as defined by Fenneman (1938), are the Blue Ridge province, the Valley and Ridge province, and the Appalachian Plateau province.

BLUE RIDGE PROVINCE

The Blue Ridge province is a belt of mountains which extends from Georgia to the Susquehanna River in Pennsylvania. North of the Roanoke River in Virginia this belt of mountains does not exceed 12 to 14 miles in width, whereas south of the Roanoke River it broadens to a maximum width of 70 miles and increases in elevation. In East Tennessee, a portion of this province extends from Virginia to Georgia, forming a belt of mountains along the North Carolina border. Collectively, the mountains are known as the Unakas. The elevation of these mountains in Tennessee ranges from 1,200 to more than 6,600 feet. The mountains are generally mantled with decayed rocks; bare slopes and talus are rare. Steep slopes of bare rocks are generally restricted to deepened river gorges rather than sharp divides.

VALLEY AND RIDGE PROVINCE

The Valley and Ridge province is a long, narrow belt of faulted and folded dominantly calcareous Paleozoic rocks. It extends for 1,200 miles from the St. Lawrence Valley to the Gulf Coastal Plain in Alabama. In Tennessee its average width is about 40 miles.

The average elevation of this province in East Tennessee is about 1,000 feet. Elevations range from a 700-foot average in Hamilton County in the south to a 1,500-foot average in Sullivan County in the north. This province, lying between the Blue Ridge province on the east and the Appalachian Plateau province on the west, is characterized by a succession of northeast trending ridges of various widths. The ridges are held up by the less soluble cherty limestone and dolomite and sandy shale, whereas the valleys are developed in the more soluble limestone, dolomite, and shale. Folding and thrusting cause nearly all the beds to dip southeast.

GEOGRAPHY

APPALACHIAN PLATEAU PROVINCE

The Appalachian Plateau province, lying just west of the Valley and Ridge province, is a low chain of folded mountains extending from the St. Lawrence River to the Gulf Coastal Plain in Alabama. In Tennessee this province is represented by the Cumberland Plateau.

That part of the Cumberland Plateau known as the Cumberland Mountains rises higher than adjacent areas. Elevations range from 2,000 to 3,500 feet but those from 2,500 to 3,000 feet are most common. The rocks of the Cumberland Plateau consist of sandstone, shale, conglomerate, and coal. They are essentially flat lying, except at the contact with the Valley and Ridge province where the formations are almost vertical.

Climate

East Tennessee does not lie directly within any of the principal storm tracks that cross the country. The area is influenced primarily by storms that pass along the Gulf Coast and thence up the Atlantic Coast, and to a lesser extent by those that pass northeastward from Oklahoma to Maine. Weather changes are frequent as compared with the stable conditions of the far Southwest, but not as frequent as in the Great Lakes region or the northeastern States (U. S. Dept. Agr., 1941).

TEMPERATURE

The difference in elevation between mountain top and valley in East Tennessee causes a considerable variation in temperature. The mean annual temperature of East Tennessee, based upon records from Chattanooga, Knoxville, and Bristol, is between 57° and 58° F. Temperature extremes of -32°F. in Johnson County and 111°F. in Blount County have been recorded. July is the hottest month and January is the coldest. The usual date of the last killing frost ranges from March 30 in Hamilton County to May 10 in Johnson and Carter Counties. The usual date of the first killing frost ranges from October 5 in Johnson and Carter Counties to October 30 in Hamilton County. The growing season varies from 150 to 210 days, depending upon latitude and elevation.

Average monthly temperatures for Chattanooga, Knoxville, and Bristol taken from Weather Bureau records (U. S. Dept. Comm., 1950) are shown in the following table:

GROUND-WATER RESOURCES OF EAST TENNESSEE

TABLE 1.—AVERAGE MONTHLY TEMPERATURES (°F.)

	Chattanooga Airport Station (1937-50)	Knoxville Airport Station (1937-50)	Bristol Airport Station (1938-50)
January	39.1	37.6	38.9
February	42.2	40.9	42.2
March	49.1	47.5	47.4
April	57.6	57.3	57.4
May	65.5	66.7	64.9
June	72.2	73.8	73.0
July	77.4	76.7	76.4
August	75.7	75.4	75.1
September	68.2	69.4	71.3
October	57.7	58.5	58.6
November	47.9	47.5	47.4
December	40.9	39.1	40.6
Average	57.8	57.5	57.8

PRECIPITATION

Precipitation in East Tennessee is controlled in part by topography. It is heavier on the Cumberland Plateau and in the Unaka Mountains than in the Valley and Ridge province. Moist air masses reach the Valley and Ridge province comparatively dry because, in passing over the mountain on either side, their moisture is condensed and precipitated. Parts of the Cumberland Plateau receive an average annual precipitation of about 55 inches, whereas in upper East Tennessee the average is about 44 inches. The amount of precipitation increases rapidly up the slopes of the Unaka Mountains. Precipitation in excess of 80 inches has been recorded on some of the mountain tops along the Tennessee-North Carolina boundary.

The valley-wide average precipitation above Hales Bar dam, which is on the Tennessee River a short distance downstream from Chattanooga, is 50.85 inches (TVA, 1950). The highest annual precipitation occurs in the mountainous area in the southeastern portion of the State along the Tennessee-North Carolina border. The lowest annual precipitation occurs in portions of Greene, Washington, and Unicoi Counties.

Rainfall is well distributed throughout the year. The wettest months are January, February, and March and the driest are September, October, and November. A quantity of water sufficient for crops generally falls during the growing season and a sufficient supply is available for ground-water recharge during the winter months. The following table gives the average monthly precipitation at Chattanooga, Knoxville, and

GEOGRAPHY

TABLE 2.—AVERAGE MONTHLY PRECIPITATION (INCHES)

	Chattanooga Airport Station (1937-50)	Knoxville Airport Station (1937-50)	Bristol Airport Station (1938-50)
January	5.26	4.66	3.65
February	4.88	4.51	3.80
March	5.78	5.05	3.81
April	4.85	4.14	3.47
May	3.77	3.75	4.09
June	4.16	4.10	3.83
July	4.25	3.36	5.10
August	4.03	3.92	3.29
September	3.11	2.68	2.72
October	3.01	2.62	2.62
November	3.36	3.07	2.45
December	5.13	4.52	3.96
Total	51.59	46.38	42.79

Mineral Resources

Many deposits of metallic and nonmetallic minerals of economic importance occur in East Tennessee. In decreasing order of dollar value, the important minerals are: coal, crushed stone, zinc, copper, marble, lime, iron, barite, and manganese. The relative standings of Tennessee mining districts, as compared with those in other states during 1952 are shown in the table below.

TABLE 3.—MINERAL PRODUCTION OF TENNESSEE FOR 1952
COMPARED WITH THAT OF OTHER STATES

Commodity	Production in short tons	Relative standing in production by States
Coal	5,265,000	10th
Zinc	38,020	8th
Copper	7,638	7th
Marble		
Crushed	15,381	2nd
Dimension	42,940	1st
Barite	14,000*	3rd (?)
Manganese	126	8th

*Estimated.

TABLE 4.—GEOLOGIC FORMATIONS IN EAST TENNESSEE—Continued

Era or system	Series	Group	Subdivisions	Thickness (feet)	Physical character	Water-bearing properties
Ordovician	Upper Ordovician		Sequatchie formation	200-400	Sequatchie: Maroon and blue shaly limestone and shale. Juniata: Maroon siltstone and shale.	Yield small supplies to wells and springs.
			Juniata formation			
			Upper part of Chickamauga limestone	700-1,000	Upper part of Chickamauga: Blue, crystalline well-bedded limestone; upper part shaly limestone. Reedsville shale: Bluish calcareous shale. Martinsburg shale: Bluish calcareous shale.	Limestones yield small to moderate quantities of water to wells and springs. Where limestones are interbedded in shale, the limestone commonly contains well-developed solution cavities. Quality of water varies. Shale generally yields larger quantities of water to drilled wells than limestone. Quality of water varies.
			Reedsville shale			
			Chickamauga limestone Unit 4			
			Martinsburg shale			
Ordovician	Middle Ordovician		Lower and middle parts of Chickamauga limestone	700-1,000	Moccasin: Maroon limy shale and shaly limestone and blue flaggy limestone. Bays: Maroon siltstone and shale.	Limestones yield small to moderate quantities of water to wells and springs. Where limestones are interbedded in shale, the limestone commonly contains well-developed solution cavities. Quality of water varies. Shale generally yields larger quantities of water to drilled wells than limestone. Quality of water varies.
	Lower Ordovician	Knock	Newala, Longview and Chepultepec formations undivided	400-800	Siliceous dolomite	
				200	Siliceous dolomite, thick limestone near base.	
				250	Very siliceous dolomite, limestone beds near top.	
				700-750	Siliceous dolomite, sandstone beds near base.	

Copper Ridge
dolomiteConococheague
limestone

900-1,100

Copper Ridge: Dark crystalline
siliceous dolomite.
Conococheague: Limestone.

other than calcium and magnesium is usually low enough not to cause any difficulty in the use of the water.

The Athens shale is about 800 to 1,000 feet thick. It is in part shaly, nodular limestone and in part bluish, yellow-weathering calcareous shale. It weathers to produce a thin acid soil containing many shale chips.

Analysis of depths of wells in Athens shale indicates that the formation behaves hydrologically as a shale rather than a limestone. In East Tennessee, calcareous shales with interbedded limestones are generally good aquifers. The solubility of both the calcareous shale and the limestone tends to make such formations quite permeable. Three springs scheduled in the Athens had yields of more than 450 gpm. Most wells produce at least domestic quantities of water.

Samples of water from 10 sources in this formation were analyzed. The hardness ranged from 46 to 404 ppm and averaged 210 ppm.

Holston formation

The Holston formation ranges in thickness from 200 to 500 feet and contains several different types of rock, including reddish-colored limestone and limy sandstone. The upper members are usually coarsely crystalline and contain quartz sand, whereas the lower portion is thinly bedded and contains more limy shale. In places, members of this formation may contain as much as 50 percent quartz sand. Fossils in the limestone indicate that parts of this formation were formed as reefs. The Holston formation weathers very deeply, producing a dark-red residuum. The members that have a high quartz content form a deep sandy soil with chips and blocks of ferruginous sandstone from which the calcium carbonate has been leached. This formation generally forms knobby red-colored hills.

Water in this formation is restricted to fractures. No large springs were scheduled, but one estimated to yield more than 100 gpm was recorded. The yield of wells drilled in the Holston formation is dependent upon the size and number of fractures intercepted. No large industrial water supply is known to be obtained from this formation, but it furnishes many domestic supplies.

Analyses of water from this formation indicate hardness of less than 150 ppm. The water is generally of good quality.

Ottosee shale

The Ottosee shale consists of about 1,000 feet of blue, yellow-weathering carbonate shale and shaly siltstone with lenses of massive crystalline limestone that becomes thin bedded at the edges. In the northwestern belt of rocks the Ottosee shale consists of a shaly nodular limestone, whereas in the southeastern belts the Ottosee is predominantly shale containing limestone lenses. The soil overlying the Ottosee

shale is rather thin and acid, except where limestone weathers to a thicker clay soil. In soil overlying the shaly phases of these rocks, chips of shale can be found. In locations underlain by limestones the soil is somewhat deeper and more fertile.

Ground water occurs in fractures in the limestone. Springs are common in the outcrop areas of these rocks. Of 24 springs scheduled, 5 were estimated to have yields of more than 450 gpm, and 11 were estimated to have yields of less than 10 gpm. The relatively pure limestone lenses in the shaly phase of the Ottosee shale may contain well-developed solution channels. The carbonate shale of the Ottosee shale also has been subjected to solution and is frequently water bearing. Of 129 wells scheduled in the Ottosee shale, 70 wells yielded at least a domestic supply of water within 100 feet. This indicates that, though the weathered Ottosee shale resembles a shale, the unweathered portion of the rock hydrologically resembles a limestone. No industrial or municipal wells are known to have been drilled in the Ottosee shale.

In chemical quality, water from the Ottosee shale resembles that from limestone formations more closely than water from shale formations. Water from the Ottosee can be expected to have a hardness of more than 100 ppm.

Sevier shale

The Sevier shale and its equivalents range in thickness from 2,500 to 4,000 feet and consist largely of blue, yellow-weathering silty to sandy calcareous shale. Locally, beds of blue shaly, nodular limestone; black carbonaceous, slightly calcareous fissile shale; blue or gray, brown-weathering sandstone; and conglomerate are found. These different rock types represent the changes in facies shown on figure 4 opposite page 66 of part II of this report. The Sevier shale usually forms rough, knobby, intricately dissected topography known locally as "slate knobs." Sandstone underlies the knobs, whereas shale free of sandstone frequently forms very flat ground. The soil is thin and full of shale chips.

Ground water in the Sevier shale is restricted to fractures. The formation has been shattered by past earth movements, making the shale rather permeable and therefore one of the better aquifers in East Tennessee. As the shale is calcareous, the fractures have been enlarged by solution to such an extent that numerous wells yield more than 150 gpm. About 50 percent of the wells scheduled in the Sevier shale obtained at least a domestic supply of water within the first 50 feet of drilling. As figures on yields are available for only a part of the wells in the Sevier shale, no conclusion can be drawn as to increase in yield with depth. Examination of cuttings from wells in the Sevier shale indicates that, though fractures are present at depth, they are usually sealed by calcium carbonate deposited from circulating ground waters.

Not a "better" aquifer, but an important one. Some of the sandstone is conglomerate.

Knox County

(Area 511 square miles, population 223,007)

GENERAL FEATURES

Knox County lies in the central part of the region covered by this report. The county is irregular in shape and is bounded by Roane, Anderson, Union, Grainger, Jefferson, Sevier, Blount, and Loudon Counties.

Knoxville, the county seat, has a population of 124,769 and is the second largest city in East Tennessee; it is about 115 miles northeast of Chattanooga. Byington, Concord, Corryton, Heiskell, Kimberlin Heights, Fountain City, Mascot, Neubert, and Powell Station are smaller communities in the county.

The county has excellent facilities for transportation. A main line and a branch line of the Southern Railway System and a main line of the Louisville & Nashville Railroad provide rail transportation to many parts of the county. The Smoky Mountain Railway connects Knoxville with the area west of the Smoky Mountains. Numerous paved roads, U. S. Highways 70, 11E, 11W, 25W, 129, and paved State Highways 71, 9, and 33 cross the county. These roads, with the many good county roads, give access to all parts of the county. Knoxville is served also by three major airlines—American Airlines, Capital Airlines, and Delta Airlines.

Knox County is largely industrial. Its industries include marble, lumber, textile and clothing, temperature controls, chemicals, and many others. Many inhabitants of the county work in large plants in nearby counties, such as the aluminum plant at Alcoa and the large Atomic Energy Commission installation at Oak Ridge.

GEOLOGY

All of Knox County lies in the Valley and Ridge physiographic province. The topography, which is typical of this province, consists of alternating ridges and valleys cut into the steeply dipping, folded and faulted calcareous rocks. The rocks include limestone, dolomite, marble, calcareous shale, sandstone, and sandy shale.

The oldest rocks exposed are those of the Rome formation of Early Cambrian age. These clastic rocks include variegated sandstone and shale.

Overlying the Rome formation is a thick sequence of limestone, dolomite, and calcareous shale, ranging in age from Middle Cambrian to Middle Ordovician. The youngest rocks exposed are those of the Clinch sandstone of Early and Middle Silurian age atop House Mountain in the northern part of the county. Immediately underlying the

Clinch sandstone is the Juniata formation of Late Ordovician age, consisting of maroon siltstone and shale. Underlying the Juniata formation is the calcareous Martinsburg shale of Middle and Late Ordovician age.

Several belts of the Holston formation, a red crystalline limestone of Middle Ordovician age that is quarried for marble, strike northeast across the county.

GROUND WATER

The occurrence of ground water in Knox County is controlled by fractures in the underlying rocks. The rocks have little primary porosity, but fracturing, due to folding and faulting, has developed a secondary porosity. In carbonate rocks, solution by percolating ground water frequently enlarges fractures to a depth of about 300 feet. Below this depth the fractures are small, and frequently have been sealed with secondary calcite.

There are three municipal water supplies in Knox County. Knoxville obtains its water supply from Fort Loudon reservoir on the Tennessee River. Fountain City uses four springs for part of its supply. Powell Station is supplied by one spring. Several industries have wells with large yields. It is estimated that the amount of ground water used in the Knoxville area exceeds 10 million gallons per day.

Most industrial wells that have yields greater than 200 gpm are located near some permanent body of water. That many of these wells have a more or less direct connection with the surface water is indicated by fluctuations in the temperature of the well water that coincide with fluctuations in the temperature of the river water.

Large springs which yield up to several thousand gallons per minute are common in Knox County. Most of these springs are in areas underlain by limestone and dolomite.

TABLE 48.—DISCHARGE MEASUREMENTS OF SELECTED SPRINGS IN KNOX COUNTY

Spring	Location	Date of measurement	Discharge (gpm)	Temperature (°F.)		Remarks
				Air	Water	
Carter Mill (no. 199-S)	3½ Miles southwest of Strawberry Plains	5/ 9/31	1,230	60	58	Clear
		7/11/31	620	84	59	Milky
		10/22/31	1,140	60	57	Clear
		6/22/50	2,110	76	59	Muddy
		7/11/50	1,275	84	59	.....
		8/ 1/50	1,297	85	59	Clear
		9/21/50	1,010	70	59	.....
		10/11/50	925	70	59	.....
		11/14/50	817	61	58	Clear
		12/19/50	938	32	58	Do.
		1/15/51	2,652	44	58	Muddy
		2/13/51	1,831	65	58	Clear
		3/21/51	2,329	52	58	Do.
		4/18/51	2,998	60	59	Do.
Boiling (no. 201-S)	4 miles south of Strawberry Plains	5/16/51	1,638	72	58	Do.
		6/13/51	1,167	76	59	.....
		5/ 9/31	5,800	64	58	Muddy
		7/11/31	1,700	85	61	Do.
		10/22/31	885	60	59	Murky
		6/21/50	3,379	75	59	Muddy
		7/11/50	2,863	82	59	Do.
		8/ 1/50	5,924	87	61	Do.
		9/21/50	2,154	72	59	.....
		10/11/50	1,705	70	59	.....
		11/14/50	1,418	54	58	Muddy
		12/19/50	2,329	31	57	Do.
		1/15/51	9,515	45	53	Do.
		2/13/51	5,341	60	56	Do.
Deep	3 miles northwest of Fountain City	3/21/51	9,470	55	56	Do.
		4/18/51	9,380	61	57	Milky
		5/16/51	4,712	78	58	Do.
		6/13/51	5,879	76	58	.....
		5/11/31	1,590	61	59	Clear
		7/13/31	556	81	59	Milky
		10/28/31	413	64	57	Clear
Seven	10 miles east of Concord	5/14/31	911	74	58	Clear
		7/ 3/31	700	91	59	Do.
		10/13/31	431	75	59	Do.
Maxwell (no. 58-S)	4 miles southwest of Bearden	6/16/50	682	83	58	Clear
		6/19/50	767	83	59	Murky
		7/12/50	579	78	58	Clear
		8/ 1/50	799	88	59	Milky
		9/14/50	512	79	60	.....
		10/11/50	408	62	59	Clear
		11/13/50	312	62	59	Do.
		12/20/50	732	40	58	Do.
		1/16/51	884	39	58	Milky
		2/20/51	1,073	72	58	Do.
		3/20/51	1,122	50	58	Clear
		4/19/51	1,153	58	58	Do.
		5/15/51	826	81	57	Do.
		6/11/51	565	73	58	Do.

TABLE 48.—DISCHARGE MEASUREMENTS OF SELECTED SPRINGS IN KNOX COUNTY—Continued

Spring	Location	Date of measurement	Discharge (gpm)	Temperature (°F.)		Remarks
				Air	Water	
Huffaker (no. 187-S)	5½ miles south of Mascot	6/21/50 7/11/50 8/10/50 9/18/50 10/11/50 11/14/50 12/20/50 1/15/51 2/13/51 3/21/51 4/18/51 5/16/51 6/13/51	1,710 68 255 83 96 105 129 1,355 423 507 781 344 206	72 78 78 83 72 58 35 43 55 54 60 78 76	60 58 59 59 59 56 58 58 58 58 58 58 59	Muddy Clear Do. Do. Do. Do. Do. Muddy Clear Clear Clear Do. Do.
Cardwell (no. 225-S)	4 miles southwest of Corrifton	6/20/50 7/11/50 8/15/50 9/12/50 10/23/50 11/22/50 12/18/50 1/16/51 2/26/51 3/19/51 4/12/51 5/15/51 6/11/51	434 288 274 226 147 237 437 853 875 934 1,001 525 485	88 83 75 76 74 42 30 67 44 39 49 82 77	61 60 61 60 59 58 55 56 58 57 57 58 59	Milky Clear Clear Milky Clear Clear Do. Muddy Milky Do. Do. Do. Cloudy
Hobbs (no. 247-S)	6 miles north of Mountain City	6/20/50 7/11/50 8/20/50 9/12/50 10/23/50 11/22/50 12/18/50 1/16/51 2/26/51 3/19/51 4/12/51 5/15/51 6/11/51	234 146 188 134 229 241 196 399 369 444 407 399 193	88 79 79 80 78 43 32 41 72 39 51 83 77	59 59 59 59 59 58 58 57 57 56 57 57 58	Clear Clear Clear Do. Do. Clear Clear Do. Do. Do. Do. Do. Clear
Fowler (no. 265-S)	2 miles west of Powell Station	6/20/50 7/11/50 8/10/50 9/12/50 10/5/50 11/14/50 12/14/50 1/16/51 2/12/51 3/19/51 4/12/51 5/8/51 6/14/51	1,328 1,144 4,326 1,126 898 817 1,880 4,425 3,402 3,743 4,847 2,042 1,194	80 74 78 71 66 36 47 31 60 44 41 72 79	59 57 58 58 57 56 57 57 56 57 57 57 57	Clear Do. Turbid Clear Do. Do. Do. Do. Milky Clear Clear Clear Do.

Analyses of representative samples of ground water from Knox County are given in table 50.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY

Shown on Plates 1, 2, 8, and 9

Method of lift: A, air lift; B, bucket; C, centrifugal; J, jet pump; L, lift pump; P, pitcher pump; T, turbine pump.
Use of water: Ab, abandoned; D, domestic; In, industrial; Ir, irrigation; P, public supply; S, stock

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Depth (feet)	Depth to water (feet)	Diameter (inches)	Probable water-bearing beds		Depth of water (feet)	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Remarks
								Character of material	Geologic horizon					
1	BEARDEN 1 mi. E.	H. K. Cook		Hilltop	1,040	100	6	Dolomite	Cr		L			D
2	1½ mi. SE.	George P. Taylor		Valley	830	120	6	do.	On		L			D
3-1	2 mi. SE.	Howell G. Davis		Hilltop	900	97	6	Limestone	Oh		L			D
3-2	do.	do.		Slope	860		6	do.	Oh		B			D
4	2 mi. S.	J. L. Roberts		Hilltop	1,050	400	6	do.	Oh	100	L	10		D
5-S	2 mi. SE.	G. W. Johnson		Valley	820		6	do.	Oh		J	150	57	D
6	3 mi. SE.	Ben Harrison		Hilltop	900		6	Shale	Oo		J			D
7-1	ROCKFORD 4 mi. NW.	J. N. Houser		do.	910	136	6	Limestone	Oh	60	J			D
7-2	do.	do.		Slope	860	125	6	do.	Oh	60	L			D
8	BEARDEN 3 mi. S.	B. F. Duncan, Jr.	Morris Forge & Drilling Co.	Ridge	830	100	35	do.	Oh	16	J			D
9	2 mi. SE.	T. H. Goodman		Hilltop	890	210	6	do.	Oh		J			D
10	2¼ mi. SE.	K. L. Hertel		Slope	910	151	6	do.	Oh	95	L	3		D
11	3 mi. SE.	Dunlap		Valley	830		6	do.	Oh		L			D
12	3 mi. E.	R. E. Dunford		Slope	850	70	8	do.	Oh	35	L			D
13	do.	Robert Whitten		do.	850	47	6	do.	Oh					Ab

Water becomes turbid after prolonged pumping.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
14	KNOXVILLE																
15-S	3½ mi. S.	E. T. Gervin	G.R. Goddard	Sink	930	69	44	8	Limestone	Ol	25		L		58	S	Spring goes dry in summer.
16-S	3 mi. S.	Doyls Spring	do.	do.	900				do.	Oh				50		D	
17	do.	C. E. Doyle	do.	do.	900				do.	Oh				100		D	
18	do.	D. Hilton	Miller	Slope	1,000	163		8	do.	Ol			L			D	
18	4 mi. SE.	Boyd Moore	do.	Valley	930	110	40	6	do.	Ol	60			5		D	
19	BEARDEN																
20	4 mi. SE.	A. A. Ginn		Slope	870	95	16	6	Shale	Oo	40		L			D	
21	do.	J. Dempster	Fitts	Hilltop	880	125	30	6	do.	Oo	35		J			D	
22-S	do.	R. M. Fox		do.	880	160	82	6	do.	Oo	50					D	
22-S	do.	J. Bakebill		Valley	840				do.	Oo						D	
23	KNOXVILLE																
24	3 mi. S.	W. A. Wilson	Fitts	do.	915	104	104	6	do.	Oo	35		J			D	Supplies three houses.
25-S	4 mi. S.	O. M. King	Gib Goddard	Ridge	870	165	35	6	do.	Oo	40		J			D	
26	do.	Rose Grubb		Valley	840				Limestone	Oh				50	57	D	
26	3½ mi. SW.	Bill Elliott		Slope	890	78	40	6	Shale	Oo	20		J			D	
27-1	BEARDEN																
27-2	3 mi. SE.	Barney Irwin		do.	900	106		6	Limestone	Oh			L			D	
28-1	do.	do.	Childress	do.	880	175		6	Shale	Oo						D	
28-1	4 mi. SE.	P. H. Davis	Morris Forge & Drilling Co.	Valley	850	135	70	6	do.	Oo	25		J			D	
28-2	do.	do.		do.	850	97		5	do.	Oo			L			D	

29	ROCKFORD																
30-S	3 mi. N.	C. T. Cates, Jr.		Hilltop	960	345		6	Limestone	Oh	175		L			D	
31-S	3½ mi. N.	DeArmond Spring		Valley	825				do.	Oh				50	57	D	
32	do.	Bliss Spring		do.	825				do.	Oh				50	57	D	
33	4 mi. N.	Wallace Harrison		Hilltop	980	165	70	6	do.	Oh	65		L			D	
33	do.	C. B. Haggard	Gib Goddard	do.	1,000	205		6	do.	Oh			L			D	
34	KNOXVILLE																
34	3 mi. S.	L. C. Shelton		do.	900	175		6	do.	Oh			L			D	
35	BEARDEN																
35	4 mi. SE.	Mark Neas	Joe Neubert	Valley	820	47	10	6	do.	Oh	12		C			D	
36	KNOXVILLE																
36	3 mi. S.	W. R. Rogers	Childress & Fitts	Ridge	950	121	40	6	Shale	Oo	44		J	5		D	
37-1	1½ mi. SW.	Robersaw-Fulton Co.		Valley	840	155		4	Dolomite	Oo	35		A	100	63	Ab	
37-2	do.	do.		do.	840	305		4	do.	Oo	35		A	250	63	Ab	
37-3	do.	do.		do.	840	505		10	do.	Oo	35		T	500	63	In	
38	1½ mi. SW.	Atlantic Co.	Price	do.	850	385	100	6	do.	Oo	13		T	480		In	
39	3½ mi. S.	W. T. Goodman	Joe Neubert	Slope	960	77		6	Limestone	Oh	14		J			D	
40	do.	Mrs. B. Braden		do.	990	103		6	do.	Oh	89		L			D	
41	3 mi. S.	H. L. Kaylor		Valley	960	190		6	do.	Ol	60					D	
42-S	do.	Bliss Spring		do.	920				do.	Oh				25	57	D	
43	3 mi. S.	Knoxville Fertilizer Co.		Slope	920	700		8	do.	Oh	300		A	100		In	
44-1	2 mi. S.	Candoro Marble Co.		Valley	870	380	10	6	Shale	Oo	65		T	500		In	
44-2	do.	do.		do.	870	350	10	6	do.	Oo	40		A			In	
45	3 mi. S.	H. B. Franklin		Hilltop	940	120	20	6	Limestone	Ol	45		J			D	

Yield drops after several hours pumping.
Well pumped at 250 gpm 24 hours a day in summer.

Well pumped at 500 gpm 24 hours a day 5 days a week.
Standby well.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
46	ROCKFORD	F. O. Hall		Slope	870	150	10	8	Shale	Oo	40		J			D	
47	3 mi. N.	A. H. Brady	Fitts	do.	865	100	20	8	Limestone	Oh			L			D	
48-S	do.	Fred Sands		Valley	850				do.	Ol				100	58	D	Water slightly milky.
49	NEUBERT	Mrs. A. Goddard		Slope	880	50	12	8	Dolomite	Ock	15		J			D	
50-S	3½ mi. SW.	Hubert Legg		Valley	880				Limestone	Ol				20	58	D	
51	3½ mi. SW.	John F. Smith		Slope	920	40		8	do.	Oh	10		J			D	
52-S	WILDWOOD	Tom Blasier		Valley	1,080				Sandstone	Cr				25	58	D	
53	ROCKFORD	Dean Pierce		Slope	1,075	78		8	Limestone	Ol			L			D	
54	WILDWOOD	Mrs. G. Goddard		Ridge	1,000	130	60	8	do.	Oh	90		L			D	
55	NEUBERT	L. Rule-		Slope	860	59	15	8	do.	Ol	25		L			D	
56	LOUISVILLE	R. H. Nichols		do.	840			8	do.	Ol	120		L			D.S	
57-1	2 mi. NE.	Park E. Getty		Valley	850	100		8	do.	Ol	40					D	
57-2	do.	do.		Slope	380	410	180	6	do.	Ol	100		L			D.S	
58-S	BEARDEN	Maxwell Spring		Valley	870				Dolomite	On				1,000	58	D	
59-S	3 mi. S.	J. M. Beardsley		do.	840				Limestone	Oh				25	57	D	
60	do.	A. F. Bradley		Slope	990	107	50	8	Dolomite	On	40		J			D	
61	4 mi. S.	Annie Jones		do.	840	152		8	Limestone	Oh	100		L			D.S	
62	do.	S. H. Kelly	Jim Miller	do.	820	88	50	8	do.	Oh	45		L			D	
63	LOUISVILLE	J. F. Scott	do.	do.	880	87	40	8	Dolomite	On	40		L	10		D.S	
64	2½ mi. N.	J. H. Tedford	L. Perry	Hilltop	850	125	40	8	Limestone	Ol	30		L			D	Well supplies three families.
65-S	3½ mi. N.	Seven Springs		Valley	820				Dolomite	On				1,200	58	D.S	Water sample analyzed.
66	1½ mi. NW.	H. H. Wells		Slope	860	92			Limestone	Oh	82		L			D	Water level fluctuates with stage of lake.
67	3 mi. NW.	H. Sterchi		do.	830	130		8	Dolomite	On	30		J			D.S	
68	3½ mi. N.	Sam Kirby	Jim Miller	Valley	830	94	20	8	Limestone	Ol	6		L			D	
69	BEARDEN	T. M. Burleson	do.	Slope	990	108	20	8	do.	Ol			J	10		D	Flowing well.
70	LOUISVILLE	R. A. Engert		Valley	860	30		38	Dolomite	Oo			J			D	Flowing well. Water sample analyzed.
71	CONCORD	C. H. Roberts		Slope	960	36		48	do.	Oo	4 2/49		L			D	
72	2½ mi. SE.	H. Hart		Valley	830	87	30	8	do.	Oo	20		L			D.S	
73	3 mi. E.	Long		Slope	840	250	14	8	do.	On	27		B			D	
74	BEARDEN	S. N. Hampson		do.	1,000	120		8	do.	Cr	60		J			D	
75	3½ mi. SW.	R. G. Gervin		do.	1,030	153		8	do.	Oo	60		L			D	
76	CONCORD	C. Delaney		Valley	880	82		8	Shale	Oo	25		L			D	
77-1	LOUISVILLE	R. E. Getty, Jr.		do.	910	179	68	8	do.	Oo	12		L	12		D.S	
77-2	5 mi. N.	do.		Hilltop	1,150	410	80	8	Limestone	Oh			L			D	Well pumps dry in 45 minutes. Recovers slowly.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
78	CONCORD																
	2 mi. E.	O. H. Schriver		Slope	860	225		6	Shale	Oo	40		J			D.S	
79-8	1½ mi. E.	A. E. Delaney		Valley	840				do.	Oo					500	57	D
80	do.	L. E. Delaney		do.	860	53	20	6	do.	Oo	0	2/49	J	10		D	Flowing well.
81	BEARDEN																
	5 mi. SW.	J. H. Bruce		Hilltop	980	120		6	Dolomite	Olv	105		L			D.S	
82	4 mi. W.	M. C. Stoner		Slope	880	92	20	6	Limestone	Cam	12		J			D.S	Water becomes cloudy after heavy rain.
83	1 mi. W.	Boyd Cain		do.	930	84		6	Dolomite	On			J			D	
84-1	2½ mi. SW.	R. T. Ritter		Hilltop	1,110	229	90	6	Limestone	Oh	143		L	3		D	
84-2	do.	do.		Ridge	1,040	508	177	6	do.	Oh	60		L	3		D	Well pumps dry in 4 or 5 hours.
85-8	do.	Oehler Spring		Slope	880				Dolomite	Car				500	58	D	Water sample analysed.
86	3½ mi. W.	Ed Walker		Ridge	930	151	35	6	do.	On			J			D	Well draws down rapidly.
87-8	do.	do.		Valley	900				do.	On				300	58	D	
88	1½ mi. N.	F. V. Birdwell	J. F. Brown	do.	960	79	35	6	Limestone	Car	8		J	40		D	
89	3 mi. N.	D. L. Roop		Slope	980	138	40	6	Dolomite	On	35		J	3		D	
90	4 mi. N.	E. H. Frasier		do.	1,070	174	85	6	do.	On			L	3		D	
91-8	4½ mi. N.	Schaad Spring		Valley					Shale	Cc				450	57	D	Water sample analysed.
92	4½ mi. NW.	W. M. Breeden		do.	1,040	87	40	6	do.	Cc	8		J			D	
93-1	3 mi. NW.	J. T. Keith		Slope	1,130	116		6	Dolomite	Oc	40		J			D.S	
93-2	do.	do.		Valley		30	30	36	do.	Oc	22		L			D.S	
94	BYINGTON																
	½ mi. E.	A. F. Smelcher		do.		54	13	6	Shale	Cc	15		J	5		D	

95-8	BEARDEN																
	4½ mi. NW.	Johnson Spring		do.					do.	Cc				150	57	D	
96	2 mi. W.	T. E. Smith		Slope	1,040	165	40	6	Dolomite	On	72		L			D	
97	BYINGTON																
	2½ mi. E.	J. T. Newcomb	J. D. Miller	do.	1,040	113	20	6	do.	Car	40		J			D	Well supplies four or five families.
98	1½ mi. E.	C. L. Sharp	do.	do.	1,030	85	85	6	Shale	Cc	20		J			D	
99-8	2 mi. E.	F. P. Neil		do.	1,060				do.	Cc				100	57	D	
100	BEARDEN																
	3½ mi. W.	J. E. Henalee	DeArmond	do.	980	124	16	6	Dolomite	On	85		J			D.S	
101	BYINGTON																
	4½ mi. S.	J. S. Reynolds	J. L. Miller	Valley	920	150	20	6	Limestone	Cam			J			D.S	
102	3 mi. S.	Wm. Smith		do.	950	90	1	6	Dolomite	On			J			D	Water becomes muddy after heavy rain.
103	2 mi. S.	Henry Jordan	Arnett	Slope	1,060	130	80	6	do.	Car	65		J			D	
104	½ mi. NW.	E. H. Buhler	DeArmond	do.	1,060	167	70	6	Shale	Oo	10		L			D.S	
105-1	2 mi. NE.	M. P. Ogg		Valley	1,000	70	30	6	Limestone	Om	30		J			In	
105-2	do.	do.		do.	1,000	70	30	6	do.	Om	30					D	
106	2½ mi. NE.	M. Mitchell	Sommers	Hilltop	1,010	86	86	6	Shale	Oo	32		J			D.S	Water milky in rainy weather.
107	1½ mi. N.	H. R. Stooksbury	Jack Fitts	Slope	1,005	150	30	6	Dolomite	O-Ck	50		L			D.S	
108	1½ mi. W.	F. L. Cox	DeArmond	do.	970	76		6	do.	O-Ck	30		L			D	
109	BYINGTON																
	1½ mi. NW.	Mrs. J. A. Cotter	J. M. Stafford	Hilltop	1,110	172	82	6	do.	O-Ck	100		J	10		D	
110	2½ mi. NW.	R. H. Officer	J. D. Miller	Slope	1,050	128	90	6	do.	O-Ck	83		J			D	
111-1	4 mi. W.	P. T. Cobb	D. Stafford	do.	850	61	33	6	Shale	Cc	25		L			D	
112	4 mi. W.	S. L. Sparks	Davis	do.	850	200	21	8	do.	Cc	12	3/49				Ab	
113	5 mi. W.	A. M. Houser	D. C. Summers	do.	840	65	32	6	Dolomite	O-Ck	42		J	6		D	
114-8	do.	W. S. Baby		Valley	770				do.	O-Ck				500	57	D	
115	2 mi. SW.	Mrs. W. P. Wallace		Slope	1,000	115	35	6	Shale	Oo	39		L			D	
116	4 mi. SW.	W. P. Walker	J. D. Miller	Valley	960	86	25	6	do.	Oo	13		J	5		D	
117-8	CONCORD																
	5 mi. NW.	Pitts Spring		do.	980				Dolomite	O-Ck				250	57	D	

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth of water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
118-S	BYINGTON 4 mi. W.	Maddox Bros.	.....	Valley	980	.....	.....	.....	Dolomite	O-Ck	.....	.....	.....	450	57	D	
119-S	7 mi. W.	Clyde Peake	.....	do.	775	.....	.....	.....	do.	O-Ck	.....	.....	.....	300	57	D	
120	CONCORD 2½ mi. N.	C. E. Keck	.....	Slope	930	128	15	6	Shale	Oo	28	.....	L	.....	.....	D	
121-S	3 mi. N.	Blue Spring	.....	Valley	920	.....	.....	.....	Limestone	Ochl	.....	.....	.....	700	58	D.S	
122	BYINGTON 3 mi. SW.	N. E. Beeler	J. Davis	Slope	1,100	89	70	6	Shale	Cc	30	.....	L	.....	.....	D.S	
123	4 mi. SW.	C. C. Lamons	.....	Valley	1,030	47	47	6	do.	Cc	18	.....	J	.....	.....	D	
124	CONCORD 4½ mi. NW.	E. V. Long	Ed Davis	Slope	1,000	37	20	6	do.	Cc	12	.....	L	.....	.....	D	
125-S	5 mi. W.	C. E. Long	.....	Valley	970	.....	.....	.....	do.	Cc	.....	.....	.....	150	.....	D	
126	MARTEL 4½ mi. N.	L. W. Perry	J. Davis	Slope	910	107	50	6	do.	Cc	10	.....	L	10	.....	D	
127	6 mi. N.	A. L. Blankenship	.....	do.	900	135	.....	6	Dolomite	O-Ck	50	.....	L	.....	.....	D	Water becomes cloudy after rains.
128	CONCORD 5½ mi. NW.	C. E. Stafford	Jim Stafford	do.	900	130	100	6	Shale	Oo	20	.....	J	.....	.....	D	
129	3½ mi. W.	H. Newberry	J. D. Miller	Valley	975	103	40	6	do.	Oo	38	.....	J	.....	.....	D	
130-S	1½ mi. NW.	John Boring	.....	do.	850	.....	.....	.....	Limestone	Cmn	.....	.....	.....	500	.....	P	
131	2½ mi. NW.	E. Meyers	J. D. Miller	Ridge	1,000	130	22	6	Shale	Oo	80	.....	J	.....	.....	D	
132	½ mi. SW.	Ben Jones	DeArmond	Hilltop	345	147	7	6	Dolomite	Oa	99	.....	J	10	.....	D.S	
133	3½ mi. S.	W. O. White	.....	Valley	900	40	40	4	do.	Ccr	5	.....	L	.....	.....	Ab	

134	MARTEL 3 mi. E.	D. C. Letts	.....	Hilltop	925	212	.....	6	do.	Ccr	.....	.....	L	5	.....	D	
135	3 mi. NE.	H. E. Walker	J. D. Miller	Valley	980	186	42	6	do.	Ccr	88	.....	J	10	.....	D	
136	3 mi. N.	J. P. Russell	Moneymaker	Hilltop	1,000	50	33	6	Limestone	Ochl	29	.....	J	10	.....	D	
137	CONCORD 2½ mi. W.	John Strother	.....	Slope	875	214	3	6	Dolomite	Oo	100	.....	L	.....	.....	D	
138	OAK RIDGE 5 mi. S.	P. T. Cobb	Davis	Valley	840	60	31	6	Shale	Cc	27	.....	L	.....	.....	D	
139	ROCKFORD 4 mi. NE.	Manley Cagle	Gib Goddard	Slope	880	94	40	6	do.	Oo	24	.....	J	20	.....	D	
140	do.	D. Baker	Childress & Fitts	do.	870	152	40	6	do.	Oo	11	.....	J	20	.....	D	
141	NEUBERT 2 mi. W.	R. C. Krapf	Gib Goddard	do.	890	92	16	6	do.	Oo	30	.....	J	.....	.....	D	Water becomes cloudy after heavy rains.
142	1 mi. S.	B. H. Cruze	Hickman & Carrigan	do.	965	70	30	6	do.	Oo	30	.....	L	.....	.....	D	
143	1 mi. E.	E. Caldwell	Parrott	Valley	970	135	20	6	do.	Oo	35	.....	J	.....	.....	D	
144-S	2 mi. E.	B. A. Bowers	.....	do.	940	.....	.....	.....	do.	Oo	.....	.....	.....	700	.....	D.S	
145	4 mi. E.	G. K. Houser	DeArmond	Slope	1,020	78	.....	6	Limestone	Oh	32	4/49	B	.....	.....	D	
146	SEYMOUR 3½ mi. NW.	L. M. Wagner	Parrott	do.	930	141	42	6	Shale	Oo	20	.....	J	15	.....	D	
147	NEUBERT 4½ mi. NE.	C. Hodges	do.	do.	850	110	17	6	Sandstone	Ob	20	.....	J	.....	.....	D	
148-1	SEYMOUR 5½ mi. NW.	Bert Hodges	.....	Valley	850	45	.....	6	Limestone	Ol	20	.....	L	.....	.....	S	
148-2	do.	do.	.....	Hilltop	910	116	.....	6	do.	Ol	50	.....	L	.....	.....	D	
149	NEUBERT 3 mi. NE.	B. L. Julian	Parrott	Slope	850	66	20	6	Sandstone	Ob	22	.....	L	.....	.....	D	
150	2 mi. NE.	H. B. Burnett	do.	Ridge	910	70	25	6	Shale	Oo	40	.....	J	.....	.....	D	Well has been pumped dry.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office.	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
151	KNOXVILLE 2½ mi. SE.	L. Nelson	Glenn White	Slope	980	168	.....	6	Limestone	Oh	.....	.....	L	.....	.....	D	Water becomes muddy frequently. Water sample analysed.
152	NEUBERT 2½ mi. NW.	A. J. McMillan	.....	do.	930	120	.....	6	do.	OI	60	.....	L	.....	.....	D	Water becomes muddy occasionally.
153	1 mi. N.	R. Perry	Cutshaw	Valley	925	100	.....	6	Shale	Oo	40	.....	J	.....	.....	P	.....
154	3 mi. N.	C. M. Shanks	.....	Ridge	890	78	.....	6	Limestone	OI	31	4/49	B	.....	.....	D	Water dingy after hard rain.
155-1	KNOXVILLE ¼ mi. E.	East Tennessee Packing Co.	Wm. Cox	Valley	830	213	40	8	Dolomite	On	45	.....	T	300	.....	D	Reported drawdown of 1 foot after 1 hour pumping at 300 gpm.
155-2	¼ mi. E.	do.	J. J. Morris	do.	840	300	44	10	do.	On	50	.....	T	375	.....	In	.....
155-3	do.	do.	.....	do.	830	100	40	8	do.	On	45	.....	A	325	.....	Ab	.....
156	1 mi. E.	Dixie Laundry Co.	Wm. Cox	do.	830	201	22	6	do.	On	20	.....	T	350	.....	In	.....
157	MARTEL 2½ mi. SW.	J. T. Hobbs	Arnett	Ridge	1,070	154	40	6	do.	Oc	.....	.....	L	.....	.....	D	.....
158	BEARDEN ¼ mi. S.	Baum's Greenhouse	Price	Valley	890	424	21	6	Shale	Oo	30	.....	T	50	.....	In	Water sample analysed.
159	KNOXVILLE 4 mi. E.	F. A. Weigel, Sr.	Perry	Slope	855	150	40	6	do.	Oo	30	.....	.....	.....	.....	Ab	.....

160-1	NEUBERT 4 mi. N.	F. A. Weigel, Jr.	J. D. Miller	Valley	880	75	.....	6	Limestone	OI	.....	.....	.....	.....	.....	Ab	.....
160-2	do.	do.	do.	do.	880	165	20	6	do.	OI	.....	.....	L	50	.....	In	.....
160-3	do.	do.	do.	do.	880	225	20	6	do.	OI	.....	.....	T	.....	.....	In	Water sample analysed.
161	KNOXVILLE 4 mi. E.	F. A. Weigel	DeArmand	Hilltop	890	225	.....	6	do.	Oh	125	.....	L	.....	.....	D.S	.....
162	NEUBERT 4½ mi. N.	Armira Monday	J. D. Miller	Valley	860	90	40	6	do.	OI	35	.....	J	.....	.....	D	.....
163	BEARDEN 2 mi. NE.	W. B. Ogle	do.	Slope	900	192	80	6	Dolomite	Oo	62	.....	L	.....	.....	D	.....
164	CONCORD In town	Aighton Memorial Baptist Church	.....	Ridge	885	220	.....	6	do.	Olv	85	.....	L	.....	.....	D	Do.
165	do.	W. A. Donovan	J. D. Miller	Slope	860	91	60	6	do.	Oc	50	.....	J	20	.....	D	Do.
166	KNOXVILLE 5½ mi. E.	R. Armstrong	Yardley	Hilltop	905	104	.....	6	Limestone	Oh	20	.....	L	.....	.....	D	Water becomes muddy after rains.
167-1	do.	J. F. Maynard	H. Drummer	Valley	848	50	21	6	Shale	Oo	0	.....	J	20	.....	In	Water sample analysed.
167-2	do.	do.	J. Stiles	do.	848	100	.....	8	do.	Oo	3	.....	J	35	.....	In	.....
167-3	do.	do.	do.	do.	846	60	.....	8	do.	Oo	0	.....	L	10	.....	In	.....
168	NEUBERT 5½ mi. NE.	A. R. Terry	J. D. Miller	Hilltop	960	122	6	6	Limestone	OI	40	.....	J	.....	.....	D	.....
169	MASCOT 5½ mi. S.	R. T. Masterson	J. C. Arnett	do.	1,110	168	147	6	Dolomite	Oma	98	.....	L	5	.....	D	Water sample analysed.
170	6 mi. SW.	J. C. Losby	Zoller	Ridge	900	51	14	6	Shale	Oo	20	.....	L	.....	.....	D	.....
171	KNOXVILLE In town	Hotel Farragut	Morris Drilling Co.	do.	940	765	110	8	Dolomite	Cr	90	.....	A	80	.....	In	.....
172	3 mi. NE.	Howell Nurseries	.....	Slope	960	150	.....	8	do.	Oc	100	.....	.....	.....	.....	Ab	.....
173	1 mi. N.	C & S Laundry	.....	Valley	900	400	.....	8	Sandstone	Ob	.....	.....	.....	.....	.....	Ab	Water too muddy to use.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
174-1	2 mi. N.	Winter Garden Co.	Morris Drilling Co.	Valley	960	1,000	.....	6	Limestone	Ccu	.....	.....	.....	3	.....	Ab	
174-2	do.	do.	do.	do.	960	400	20	6	do.	Ccu	.....	.....	T	60	.....	In	
174-3	do.	do.	do.	do.	960	250	20	8	do.	Ccu	20	.....	T	400	.....	In	
175	1½ mi. W.	Gray Knox Marble Co.	.....	Slope	870	500	.....	3	Shale	Oo	30	.....	T	500	.....	In	
176	1 mi. W.	Rohm & Haas Co.	Southern Railway	Valley	890	160	20	.....	Sandstone	Ob	34	.....	T	100	.....	Ab	
177	2 mi. S.	Vestal Lumber Co.	.....	do.	830	300	.....	6	Shale	Oo	25	.....	A	100	.....	In	
178	2½ mi. N.	J. Allen Smith Co.	Morris Drilling Co.	do.	900	380	33	8	Sandstone	Ob	100	.....	T	80	.....	In	
179-1	3 mi. E.	W. M. Johnson	do.	Sink	900	120	30	6	Limestone	Ob	15	.....	J	1	.....	D	
179-2	do.	do.	do.	Slope	860	110	25	6	do.	Ob	15	.....	J	.....	.....	D.S	
179-3	do.	do.	do.	do.	840	75	.....	6	do.	Ob	30	.....	L	.....	.....	Ab	
180	2 mi. N.	Cockrum Lumber Co.	.....	do.	920	75	.....	6	Dolomite	On	25	.....	L	.....	.....	In	
181	do.	Tennessee Flooring Co.	.....	do.	930	250	.....	6	do.	On	20	.....	T	120	.....	In	
182	BEARDEN 1½ mi. E.	Cherokee Country Club	Morris Drilling Co.	do.	980	709	.....	6	do.	Ccr	200	.....	T	20	.....	In	
183-8	SEYMOUR 3 mi. N.	F. L. Rousser	.....	do.	870	.....	.....	.....	do.	O-Ck	.....	.....	.....	1,000	.....	D	
184-1	5 mi. N.	C. C. Gose	M. S. King	Valley	865	113	45	6	Shale	Oo	31	.....	J	.....	.....	D.S	
184-2	do.	do.	do.	do.	865	40	.....	48	Sandstone	Ob	35	.....	L	.....	.....	D	
185	3½ mi. N.	W. Trunde	.....	Hilltop	1,010	200	.....	6	Dolomite	O-Ck	50	.....	J	.....	.....	D.S	

186	MASCOT 5 mi. S.	S. W. King	Jake Nicely	Slope	940	101	.....	6	do.	Oma	33	.....	L	.....	.....	D	
187-8	5½ mi. S.	E. R. Hudaker	.....	do.	900	.....	.....	.....	do.	Oma	.....	.....	.....	1,500	58	D.S	
188	BOYDS CREEK 5 mi. NW.	Burt Clifton	M. Coker	Hilltop	950	92	.....	6	Shale	Oo	32	.....	B	.....	58	D	
189	3 mi. NW.	J. W. Inzie	.....	Slope	990	.....	.....	6	Limestone	Ol	25	.....	L	.....	.....	D	
190	2½ mi. NW.	J. B. Kelly	.....	do.	910	.....	.....	6	Shale	Cpv	.....	.....	L	.....	.....	D.S	
191	4 mi. N.	W. K. Clifton	.....	do.	980	54	.....	6	do.	Oo	27	2/49	B	.....	58	D	
192	KODAK 4½ mi. NW.	J. A. Hancock	Styles	do.	980	103	.....	6	do.	Oo	23	.....	J	.....	.....	D	
193	MASCOT 1 mi. NW.	W. Miller	Arnett	Hilltop	980	252	.....	6	Limestone	Ccu	.....	.....	L	.....	.....	D	
194-1	3 mi. N.	Earl Jones	.....	do.	1,010	90	.....	6	do.	Ccu	.....	.....	L	.....	.....	D	
194-2	do.	do.	.....	Slope	1,010	90	.....	6	do.	Ccu	.....	.....	L	.....	.....	D	
195-8	STRAW- BERRY PLAINS 3 mi. N.	Mrs. B. H. Hudson	.....	Valley	920	.....	.....	.....	Dolomite	Oma	.....	.....	.....	500	.....	D.S	
196-8	MASCOT 2 mi. NE.	M. Cobb	.....	do.	980	.....	.....	.....	Limestone	Ol	.....	.....	.....	500	59	D.S	
197	2½ m. S.	Helmas Grill	.....	Slope	960	250	.....	6	Shale	Oo	.....	.....	.....	.....	.....	P	
198-8	3½ mi. S.	M. R. Weaver	.....	Valley	990	.....	.....	.....	Dolomite	Oma	.....	.....	.....	150	59	D	
199-8	STRAW- BERRY PLAINS 3½ mi. SW.	Carter Mill Springs	.....	do.	915	.....	.....	.....	do.	Ok	.....	.....	.....	4,000	59	.....
200-8	4 mi. S.	Ode Racine	.....	do.	890	.....	.....	.....	Limestone	Ol	.....	.....	.....	200	59	D.S	
201-8	do.	Boiling Springs	.....	do.	900	.....	.....	.....	do.	Ol	.....	.....	.....	4,000	59	D.S	
202-8	2 mi. S.	J. N. Bailey	.....	do.	940	.....	.....	.....	Dolomite	Oma	.....	.....	.....	20	60	S	
203	1½ mi. SW.	W. Stout	.....	Hilltop	950	105	.....	6	Shale	Oo	14	.....	L	.....	.....	D	

Water becomes muddy after hard rain.

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
204	MASCOT 2 mi. SE.	Irene Wilson	.....	Hilltop	945	75	.....	6	Shale	Oo	.....	.....	L	.....	.....	D	
205	1½ mi. S.	Clyde Bates	.....	Valley	895	70	.....	6	do.	Oo	18	.....	J	.....	.....	D	
206	STRAW-BERRY PLAINS 3 mi. S.	Lon Shackfort	.....	Slope	1,190	200	.....	.....	Dolomite	Oo	.....	.....	B	.....	.....	D	
207	FOUNTAIN CITY 5 mi. E.	J. T. McElroy	Tom McNutt	Valley	840	209	40	6	Shale	Oo	57	.....	.....	.....	.....	Is	
208	MASCOT 5 mi. SW.	L. W. Stipe	.....	Slope	940	105	40	6	do.	Oo	50	.....	J	.....	.....	D	
209	3½ mi. SW.	Westland Dairy	.....	Valley	900	200	.....	6	do.	Oo	.....	.....	L	.....	.....	In.S	
210	2 mi. SW.	John E. Blake	.....	Slope	870	78	.....	6	do.	Oo	30	.....	J	.....	.....	D.S	
211	do.	Rennie Blake	.....	Hilltop	925	79	.....	6	do.	Oo	.....	.....	L	.....	.....	D	
212	do.	Hall Blake	.....	Slope	875	200	.....	6	do.	Oo	.....	.....	L	50	.....	D.S	
212	5 mi. SW.	Emmert Pratt	.....	do.	930	100	.....	6	do.	Oo	40	.....	B	.....	.....	D	
214-S	FOUNTAIN CITY 4½ mi. SE.	F. C. Clanton	.....	Valley	895	.....	.....	.....	do.	Oo	.....	.....	.....	30	61	D	
215-S	4½ mi. E.	Netherland Heights Spring	Tom McNutt	do.	990	.....	.....	.....	Sandstone	Cc	.....	.....	.....	200	59	D	
216	3½ mi. E.	Earl Johnson	.....	Hilltop	1,030	185	.....	6	Shale	Cc	.....	.....	L	.....	.....	D	
217	4½ mi. SE.	G. Smith	.....	Slope	1,020	150	.....	6	Dolomite	Olv	.....	.....	L	.....	.....	D	Water very muddy.
218	MASCOT 5 mi. W.	Jones Food Market	.....	do.	930	106	.....	6	do.	Ok	80	.....	J	.....	.....	D	
219	do.	Henry Nance	.....	do.	1,015	162	.....	6	Limestone	Ccn	.....	.....	J	.....	.....	D	
220	3 mi. W.	Michael Meadow	.....	do.	970	125	.....	6	Dolomite	Olv	.....	.....	L	.....	.....	D	
221-S	FOUNTAIN CITY 5 mi. NE.	Vandergrift Spring	.....	do.	1,120	.....	.....	.....	Shale	Cc	.....	.....	.....	10	57	D	
222	CORRYTON 5 mi. SW.	W. H. Anderson	.....	Hilltop	1,130	130	.....	6	do.	Omb	.....	.....	L	.....	.....	D.S	
223	4 mi. SW.	A. G. Wood	.....	do.	1,125	90	.....	6	do.	Omb	.....	.....	L	.....	.....	D.S	
224	MASCOT 5½ mi. W.	R. T. Everett	.....	do.	1,115	.....	.....	6	do.	Oo	.....	.....	J	.....	.....	D	
225-S	CORRYTON 4 mi. SW.	Roy Cardwell	.....	Valley	1,030	.....	.....	.....	Limestone	Ochl	.....	.....	.....	500	57	D	Water sample analyzed.
226-S	FOUNTAIN CITY 4½ mi. NE.	P. M. McCarley	.....	do.	1,060	.....	.....	.....	Shale	Oo	.....	.....	.....	20	58	D	Do.
227	do.	J. C. McCord	.....	Slope	1,100	135	.....	6	Limestone	Ochl	50	.....	L	.....	.....	D	
228	CORRYTON 2½ mi. SW.	Sprinkle Grocery	.....	Valley	1,065	86	.....	6	Shale	Oo	.....	.....	L	.....	.....	D	
229	MASCOT 4 mi. NW.	Clyde W. Adkins	.....	Slope	1,055	112	.....	6	do.	Omb	.....	.....	J	.....	.....	D	
230	4 mi. W.	M. Muncy	.....	Valley	1,070	104	.....	6	Limestone	Ccn	30	.....	L	.....	.....	D	
231-S	do.	Charlie Mynatt	.....	do.	1,160	.....	.....	.....	do.	Ccn	.....	.....	.....	50	58	D.S	
232	2 mi. NW.	Wilson & Harris	.....	do.	980	115	20	6	do.	Ccn	.....	.....	L	.....	.....	In	
233	2 mi. W.	Jess Brooks	.....	Hilltop	1,020	240	.....	6	Dolomite	Oe	115	.....	L	.....	.....	P	Supplies six residences and one store.
234-S	FOUNTAIN CITY In town	.....	.....	Valley	990	.....	.....	.....	Shale	Oo	.....	.....	.....	10	.....	.....
235-S	do.	W. Clark	.....	do.	970	.....	.....	.....	do.	Oo	.....	.....	.....	80	.....	.....

TABLE 49.—TYPICAL WELLS AND SPRINGS IN KNOX COUNTY—Continued

Well or spring No.	Location with reference to nearest post office	Owner or name	Driller	Topographic situation	Altitude (feet)	Depth of well (feet)	Length of casing (feet)	Diameter (inches)	Probable water-bearing beds		Depth to water level (feet)	Date of measurement	Method of lift	Yield (gallons per minute)	Temperature (°F.)	Use of water	Remarks
									Character of material	Geologic horizon							
236-S	2½ mi. NE.	Beverly Hills Sanatorium	Valley	1,040	Dolomite	Olv	1,000	57	D,S	Considerable seasonal variation.
237-S	3¼ mi. E.	John Babley	.....	Slope	1,000	.....	.....	.....	Shale	Cc	.....	.....	.....	200	57	D
238	HEISKELL 4 mi. NE.	E. L. Holbert	Summers	do.	920	94	.....	6	do.	Ccm	10	.....	.....	.....	.....	D
239	3 mi. E.	Glen Lewis	John Davis	do.	890	77	5	6	Limestone	Ccu	.....	.....	.....	.....	.....	D
240-S	4½ mi. NE.	Knox County	.....	do.	1,050	.....	.....	.....	do.	Ccu	.....	.....	.....	500	58	D
241-S	FOUNTAIN CITY 4½ mi. NW.	Lewis Dail	Valley	1,150	Dolomite	Oc	100	57	D	Water slightly turbid. Well pumped at 500 gpm for 7 days. Water too turbid for use. Water sample analyzed.
242-1	in town	Knox County Water Works	Morris Drilling Co.	do.	970	300	300	8	Limestone	Ochl	0 3/48	.....	.....	500	57	Ab
242-2-S	do.	do.	.....	do.	990	.....	.....	.....	Dolomite	Oma	.....	.....	.....	300	.....	P
242-3-S	do.	do.	.....	Slope	975	.....	.....	.....	do.	Oma	.....	.....	.....	30	.....	P
242-4-S	½ mi. SW.	do.	.....	Valley	980	.....	.....	.....	Limestone	Ochl	.....	.....	.....	25	.....	P
242-5-S	do.	do.	.....	Slope	980	.....	.....	.....	do.	Ochl	.....	.....	.....	200	.....	P
243-S	3 mi. NW.	Big Spring	.....	Valley	1,010	.....	.....	.....	Shale	Oo	.....	.....	.....	500	.....	.....
244-S	4 mi. NW.	.....	.....	do.	1,100	.....	.....	.....	Dolomite	Olv	.....	.....	.....	10	58	S
245-S	POWELL STATION 2¼ mi. NE.	H. M. Rood	.....	do.	1,000	.....	.....	.....	Shale	Oo	.....	.....	.....	500	57	D
246-S	FOUNTAIN CITY 5 mi. N.	Wells & Rusb	.....	do.	1,190	.....	.....	.....	Dolomite	Oc	.....	.....	.....	10	57	D

247-S	6 mi. N.	H. B. Hobbs	do.	1,140	do.	Oc	500	58	D	Water sample analyzed.
248-1	4½ mi. N.	G. W. Crippen	Irvin Cant	Slope	1,070	24	.....	6	Limestone	Om	.....	.....	.....	.....	.....	D
248-2	do.	do.	Otis Sweet	do.	1,075	87	.....	6	do.	Om	.....	.....	.....	.....	.....	D
248-3	do.	do.	Vinyard	do.	1,100	90	.....	6	do.	Om	.....	.....	.....	.....	.....	D
249	6 mi. NE.	G. W. Dozier	.....	do.	1,145	65	.....	6	do.	Om	.....	.....	.....	.....	.....	D
250	2¼ mi. N.	Norah Watson	Roscoe Summers	do.	1,080	108	do.	Om	D	Water sample analyzed.
251-S	3 mi. NE.	John L. Powell	.....	Valley	1,080	.....	.....	.....	Shale	Cc	.....	.....	.....	10	57	D
252	do.	Glenn Donsett	.....	Hilltop	1,120	100	.....	6	do.	Cc	.....	.....	.....	.....	.....	D
253	2 mi. NW.	A. E. Forman	Roscoe Summers	Slope	1,080	214	90	6	do.	Cc	.....	.....	.....	.....	.....	D
254-S	POWELL STATION 2¼ mi. E.	Community Spring	.....	Valley	1,020	.....	.....	.....	do.	Cc	.....	.....	.....	300	58	D
255	FOUNTAIN CITY 4 mi. SW.	W. P. McFadden	Slope	1,105	100	6	Dolomite	Ok	P	Supplies water for 20 trailers.
256-S	HEISKELL 3 mi. NE.	Foster Hopkins	Valley	935	Limestone	Olme	5	59	D	Water sample analyzed.
257	do.	Charlie Hewett	.....	do.	880	17	.....	34	Shale	Ccm	4	.....	.....	.....	.....	D
258	do.	N. L. Lewis	Dillon Summers	Slope	890	85	.....	6	do.	Ccm	.....	.....	.....	.....	.....	D
259	1 mi. N.	Chas. E. Manning	.....	do.	920	22	.....	48	Dolomite	Om	.....	.....	.....	.....	.....	D
260	¼ mi. W.	Summers, Sr.	Roscoe Summers	Valley	900	60	10	6	Limestone	Olme	10	.....	.....	.....	.....	D
261	2 mi. SW.	L. T. Yarnell	Otis Sweet	do.	885	85	18	6	do.	Olme	60	.....	.....	.....	.....	D
262-S	2 mi. E.	Hugh Henry	.....	do.	855	.....	.....	.....	Shale	Ccm	.....	.....	.....	2	58	D
263	POWELL STATION 1¼ mi. NE.	E. L. Seymore	.....	Slope	1,100	146	40	6	Dolomite	O-Ck	90	.....	.....	.....	.....	D,S
264	HEISKELL 1 mi. SE.	D. P. Lindsay	Roscoe Summers	do.	900	54	40	6	Shale	Ccm	30	7/49	J	.....	.....	D

TABLE 50.—ANALYSES OF GROUND WATER IN KNOX COUNTY
(Chemical constituents in parts per million)

Well or spring No.	Owner or name of spring or well	Geologic horizon	Date of collection	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na & K)	Carbonate (CO ₃)	Bicarbonate (HCO ₃)	Sulfate (SO ₄)	Chloride (Cl)	Fluoride (F)	Nitrate (NO ₃)	Hardness as CaCO ₃	Specific Conductance (Micromhos at 25°C.)	pH
65-S	Seven Springs	On	2/ 7/49	0.09	19	9.6	.....	12	101	2	2.0	.....	.....	87	193	8.3
70	R. A. Engert	Oc	4/19/50	.12	19	10	2.6	0	104	3	2.5	0	2.9	88	183	7.7
85-S	Oehler Spring	Ccr	4/17/50	.07	33	19	.9	0	180	6	4.0	0	3.7	160	282	8.2
91-S	Schaad Spring	Co	4/19/50	.08	40	12	.2	0	172	3	2.0	0	3.3	149	271	8.3
151	L. Nelson	Oh	5/ 7/49	.07	32	6.4	.....	0	93	25	6.5	.....	.....	106	248	7.6
158	Baum's Greenhouse	Oo	4/14/49	.08	23	9.3	.....	0	119	17	7.5	.....	.....	96	295	8.1
160-3	F. A. Weigel, Jr.	Ol	9/ 7/50	.09	33	3.2	.....	0	101	5	1.8	0	3.7	90	176	8.1
164	Aighton Memorial Baptist Church	Olv	4/19/50	.31	38	30	2.9	0	201	3	9.2	0	.....	177	327	7.5
165	W. A. Donovan	Oo	5/18/49	.09	23	11	.....	0	127	3	1.0	.....	.....	103	216	8.1
167-1	J. F. Maynard	Oo	9/ 7/50	.10	32	9.2	.....	0	134	14	7.2	0	4.3	118	263	8.2
169	R. T. Masterson	Oma	5/21/49	.11	27	8.1	.....	16	121	2	1.5	.....	.....	101	242	8.4
225-S	Roy Cardwell	Ochl	4/17/50	.12	44	11	11	0	211	3	1.5	0	.....	155	331	7.6
226-S	P. M. McCauley	Oo	4/17/50	.15	31	4.1	5.6	0	119	3	3.2	0	1.7	94	205	8.1
242-2-S	Knox County Water Works	Ochl	4/17/50	.11	38	17	1.5	0	188	5	6.2	0	.....	165	319	8.4
248-2	G. W. Crippen	Om	4/17/50	.08	28	15	7.4	0	284	44	9.8	.1	.....	132	491	8.5
260	Summers, Sr.	Olmc	4/18/50	.07	25	14	1.4	0	140	2	3.8	0	1.1	120	216	8.2
265-S	Fowler Spring	O Ck	4/18/50	.05	30	17	2.5	0	173	2	1.8	0	2.8	143	268	8.4
270-S	Gills & Fletcher	O Ck	4/18/50	.05	23	11	.6	0	113	3	2.0	0	6.9	103	194	8.2
274	R. G. Julian	Om	4/17/50	.07	68	2.0	13	0	213	20	3.5	.1	.....	173	398	8.3
287	Anna Wood	Ccu	4/17/50	.15	68	7.8	5.4	0	238	6	8.5	.1	202	394	8.4

GROUND-WATER RESOURCES OF EAST TENNESSEE

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" Endangered Species And Critical Or Sensitive Habitat "

TDEC/Division of Natural Heritage (DNH). 1997. "Project review information for endangered species and critical or sensitive habitat," memorandum to F. Grubbs (TDEC/DSF/NCO) from A. Barass (TDEC/DNH), dated October 8. Smokey Mountain Smelters Project, along Flenniken Branch to Tennessee River, near Knoxville, Knox County, TN.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION

DIVISION OF
SUPERFUND

JD 10-9-96
JTW 10/8/96

107 OCT -2 AM 9:17

TENNESSEE DEPARTMENT OF
ENVIRONMENT AND CONSERVATION

October 8, 1996

MEMORANDUM

To: Mr. Frank Grutbs, Deputy Director
Division of Superfund, TDEC

From: Andrew N. Barrass, Ph. D.,
Environmental Review Coordinator
Division of Natural Heritage, TDEC

Subject: Project review information for endangered species and critical or sensitive habitat

Please be advised that a review of our Departmental data bases indicates recorded threatened and/or endangered species near the project boundaries and within a one mile radius of the proposed project. These species have very specific or rare habitat. Please see the attached listing for further *habitat* information. Our records also indicate additional species occurrence records within an approximate four mile radius of the proposed project site(s). The review is for the proposed Smokey Mountain Smelters Project [TDSF #47559], along Flenniken Branch to Tennessee River, near Knoxville, Knox County, TN project site(s). As per your request, the species that have recorded occurrences are listed by quad map and are attached.

The information provided is sensitive to the protection of rare habitat, threatened or endangered species, and natural areas which our Department has the responsibility to protect. Therefore, we would request that this information only be used as a research tool by your professional staff and not be made available to the public or anyone outside of your Division.

The results of our review do not mean that a comprehensive biological survey has been completed. Because of the presence of threatened or endangered species near the project area (within a mile radius), it is probable that those species will occur in the project area if suitable habitat exists. Therefore we would *recommend* that a survey of the project sites be conducted prior to project implementation. Please notify our office of your findings.

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Mr. Frank Grubbs, DSF-TDEC

October 8, 1996

We recognize the importance of stream bank habitat to improving water quality and preventing soil erosion. We would suggest that stream bank, stream side and riparian zones be restored to habitat that is representative of eco-specific communities found within the project area. Any restoration activities should include the use of native plant species.

In order to comply with the National Environmental Policy Act consideration should be given to the comprehensive and *cumulative* impacts associated with the project actions. Based upon the information provided, it is probable that any proposed stream crossing will impact instream, aquatic, habitat and riparian habitat as part of the construction. Techniques for streamside reconstruction and sediment retention are outlined in the following documents prepared by our Department:

1. **Tennessee Erosion Control Handbook, July 1992.**
2. **Reducing Nonpoint Source Water Pollution by Preventing Soil Erosion and Controlling Sediment on Construction Sites, March 1992.**
3. **Riparian Restoration and Streamside Erosion Control Handbook, November 1994.**

Please refer to the documents when planning measures to lessen the construction impacts.

In addition to our standard project review and data search of the **Biological Conservation Data System**, we typically include information from the **Rivers Assessment Program** data base. The Rivers Assessment Program provides information on the ecological, recreational and aesthetic quality of the river corridors. The data is particularly useful in evaluating the potential for riparian habitat impacts as well as downstream aquatic habitats and recreational impacts of the proposed project. This information however, is currently *not* available for this watershed (please see attached Memo).

We appreciate the opportunity to assist you with your pre-project planning. If we can be of further assistance with your project or by interpreting data elements please contact our office in Nashville, telephone 615/532-0431.

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Mr. Frank Grubbs, DSF-TDEC

October 8, 1996

Please find attached the listings of the various data occurrences or elements from our Biological Conservation Data System, BCD, that have been retrieved from our computer data bases. The information provided is current for this quarter of the calendar year. Our information is continuously being updated and future searches may result in expanded data listings for this specific project investigation.

Definitions of BCD Data Elements:

COUNTYNAME = Tennessee County Name

MANAME = Managed Area Name

QUADNAME = Quad Map Name

SCOMNAME = State Listed, Species Common Name

SITENAME = Site Name for Natural Area, Critical or Sensitive Habitat

SNAME = Species Name

Attachments: (4)

Recently our office assisted your Division with developing Environmental Assessments for various projects. Please note that on February 28, 1996, the U.S. Fish and Wildlife Service published changes to the list of Federal Threatened or Endangered Species, "**Candidate**" species. The most obvious change to this new listing will be the exclusion of many species, formerly "C2" and "3C", from the listing. This change may affect your environmental planning for current or future projects.

Important Notice: The Federal protection status for "Candidate" species, as a candidate for threatened or endangered species listing, has changed as of February 28, 1996. The change of status was published in the **Federal Register**, Vol. 61 No. 40, pages 7596-7613. Additional information concerning these species and the change in status may be obtained by contacting the U.S. Fish and Wildlife Service, in Atlanta GA, @ 404/679-7096.

HABITAT INFORMATION FOR ENDANGERED SPECIES AND CRITICAL OR SENSITIVE HABITAT FOR LOCATIONS NEAR THE PROJECT SITE AND WITHIN ONE MILE OF THE PROJECT SITE:

The following habitat description has been retrieved from our national data base for the purpose of scientific field review and population determinations. The following species occurrence record is associated with the Tennessee River and the proposed PPE for the project.

Spiny River-Snail:

IO FLUVIALIS *Found in shallow waters of shoals that are rapid to moderate and well-oxygenated. **

Note: This species currently does not have any special State or Federal protection status. The species and roost sites are considered significant and are tracked by our Division staff.

Because the habitat for the animal species listed is very specific, you may wish to request further information from our zoologist, Mr. David Withers, in our office in Nashville. He may be reached by telephone at 615/532-0431.

Note:

Should the project require further environmental program permits from our Department, please attach a complete copy of this review or assessment to the permit application.

LIST OF RARE, THREATENED, AND ENDANGERED SPECIES FOR THE KNOX, SBOOKS GAP, & BEARDEN QUADS, TN; DSF/DNH-TDEC PROJECT
08 OCT 1997

SCIENTIFIC NAME	COMMON NAME	FEDERAL STATE STATUS	GLOBAL STATE STATUS	RANK	RANK
INVERTEBRATES					
ATHEARNIA ANTHONYI	ANTHONY'S RIVER SNAIL	LE	E	G1T1	S1
DROMUS DROMAS	DROMEDARY PEARL MUSSEL	LE	E	G1	S1
EPIOBLASMA TORULOSA TORULOSA	TUBERCLED BLOSSOM	LE	E	G2TX	SX
FUSCONAIA EDGARIANA	SHINY PIGTOE	LE	E	G1	S1
IO FLUVIALIS	SPINY RIVERSNAIL			G2	S2
LITHASIA GENICULATA	ORNATE ROCKSNAIL			G1G3	S2
LITHASIA VERRUCOSA	VARICOSE ROCKSNAIL			G7	S3
PLETHOBASUS COOPERIANUS	ORANGE-FOOT PIMPLEBACK	LE	E	G1	S1
QUADRULA INTERMEDIA	CUMBERLAND MONKEYFACE	LE	E	G1	S1
PLANTS					
ARABIS PATENS	SPREADING ROCKCRESS		E	G3	S1
AUREOLARIA PATULA	SPREADING FALSE-FOXGLOVE		T	G2G3	S2
CARDAMINE FLAGELLIFERA	RUNNING BITTERCRESS		T	G3	S2
CIMICIFUGA RUBIFOLIA	APPALACHIAN BUGBANE		T	G3	S3
HYDRASTIS CANADENSIS	GOLDENSEAL		S-CZ	G4	S3
ONOSMODIUM MOLLE SSP OCCIDENTALE	WESTERN FALSE GROMWELL		T	G4G5T4	S1S2
PANAX QUINQUEFOLIUS	AMERICAN GINSENG		S-CZ	G4	S3S4
SAXIFRAGA CAREYANA	CAREY'S SAXIFRAGE		S	G3	S3
VERTEBRATES					
ACCIPITER STRIATUS	SHARP-SHINNED HAWK		D	G5	S2
ANGUILLA ROSTRATA	AMERICAN EEL			G5	S3
CARPICODON VELIFER	HIGHFIN CARPSUCKER		D	G4G5	S3
CRYPTOBRANCHIUS ALLEGANIENSIS	HELLBENDER		D	G4	S3
FALCO PEREGRINUS	PEREGRINE FALCON	E/SA	E	G4	S1N
GYRINOPHILUS PALLIDUS	TENNESSEE CAVE SALAMANDER		T	G2	S2
LOBATHEUS EXILIS	LEAST BITTERN		D	G5	S2
MELANERPES ERYTHROCEPHALUS	RED-HEADED WOODPECKER			G5	S4
MYOTIS GRISESCENS	GRAY BAT	LE	E	G3	S2
NOTURUS FLAVIPINNIS	YELLOWFIN MADTOM	LECN	E	G1	S1
SOREX LONGIROSTRIS	SOUTHEASTERN SHREW		D	G5	S4
TRACHEMYS SCRIPTA TROOSTII	CUMBERLAND SLIDER			G5T3T4	S3S4
TYTO ALBA	COMMON BARN-OWL		D	G5	S3S4

30 Records Processed

QUADNAME:..... SCONAME:..... STATE:..... FEDERAL STATE SRANK:.....

SHOOKS GAP	TENNESSEE CAVE SALAMANDER	GYRINOPHILUS PALLEUCUS	T	32
SHOOKS GAP	TENNESSEE CAVE SALAMANDER	GYRINOPHILUS PALLEUCUS	T	32
SHOOKS GAP	LEAST BITTERN	IXOBRYCHUS EXILLIS	D	32
SHOOKS GAP	SHARP-SHINNED HAWK	ACCIPITER STRIATUS	D	32
SHOOKS GAP	COMMON BARN-OWL	TYTO ALBA	D	3334
SHOOKS GAP	COMMON BARN-OWL	TYTO ALBA	D	3334
SHOOKS GAP	AMERICAN EEL	ANGUILLA ROSTRATA		33
SHOOKS GAP	HIGHFIN CARPSUCKER	CARPIODES VELIFER	D	33
SHOOKS GAP	DROMEDARY PEARLYMUSSEL	DROMUS DROMAS	LE	3
SHOOKS GAP	DROMEDARY PEARLYMUSSEL	DROMUS DROMAS	LE	2
SHOOKS GAP	SHINY PIGTOE	FUSCONAIA EDGARIANA	LE	2
SHOOKS GAP	ORANGE-FOOT PIMPLEBACK	PLETHOBASUS COOPERIANUS	LE	3
SHOOKS GAP	CUMBERLAND MONKEYFACE	QUADRULA INTERMEDIA	LE	3
SHOOKS GAP	SPINY RIVERSNAIL	IO FLUVIALIS		32
SHOOKS GAP	VARIKOSE ROCKSNAIL	LITHASIA VERRUCOSA		33
SHOOKS GAP	WESTERN FALSE CROWWELL	CROCOTIDUM MOLLE SSP OCCIDENTALE	T	3132
SHOOKS GAP	WESTERN FALSE CROWWELL	CROCOTIDUM MOLLE SSP OCCIDENTALE	T	3132
SHOOKS GAP	GOLDENSEAL	HYDRASTIS CANADENSIS	S-CE	33
KNOXVILLE	HELLBENDER	CRYPTOBRAUCHUS ALLEGANIENSIS	D	33
KNOXVILLE	TENNESSEE CAVE SALAMANDER	GYRINOPHILUS PALLEUCUS	T	32
KNOXVILLE	PEREGRINE FALCON	FALCO PEREGRINUS	Z/SA	3
KNOXVILLE	COMMON BARN-OWL	TYTO ALBA	D	3334
KNOXVILLE	RED-HEADED WOODPECKER	MELANERPES ERYTHROCEPHALUS		34
KNOXVILLE	YELLOWFIN MADTOM	NOTURUS FLAVIPINNIS	LIXN	2
KNOXVILLE	SOUTHEASTERN SHREW	SOREX LONGIROSTRIS	D	34
KNOXVILLE	CUMBERLAND SLIDER	TRACHENYS SCRIPTA TROOSTII		3334
KNOXVILLE	CUMBERLAND SLIDER	TRACHENYS SCRIPTA TROOSTII		3334
KNOXVILLE	SIX-LINED RACERUNNER	CYEMIDOPHORUS SEXLINEATUS		33
KNOXVILLE	SIX-LINED RACERUNNER	CYEMIDOPHORUS SEXLINEATUS		33
KNOXVILLE	SIX-LINED RACERUNNER	CYEMIDOPHORUS SEXLINEATUS		33
KNOXVILLE	DROMEDARY PEARLYMUSSEL	DROMUS DROMAS	LE	3
KNOXVILLE	DROMEDARY PEARLYMUSSEL	DROMUS DROMAS	LE	3
KNOXVILLE	DROMEDARY PEARLYMUSSEL	DROMUS DROMAS	LE	3
KNOXVILLE	DROMEDARY PEARLYMUSSEL	DROMUS DROMAS	LE	3
KNOXVILLE	TUBERCLED BLOSSOM	EPICHLASMA TORULOSA TORULOSA	LE	3
KNOXVILLE	ORANGE-FOOT PIMPLEBACK	PLETHOBASUS COOPERIANUS	LE	3
KNOXVILLE	ORANGE-FOOT PIMPLEBACK	PLETHOBASUS COOPERIANUS	LE	3
KNOXVILLE	ORANGE-FOOT PIMPLEBACK	PLETHOBASUS COOPERIANUS	LE	3
KNOXVILLE	SPINY RIVERSNAIL	IO FLUVIALIS		32
KNOXVILLE	SPINY RIVERSNAIL	IO FLUVIALIS		32
KNOXVILLE	ANTHONY'S RIVER SNAIL	ATHEARNIA ANTHONYI	LE	3
KNOXVILLE	ORNATE ROCKSNAIL	LITHASIA GENICULATA		32
KNOXVILLE	VARIKOSE ROCKSNAIL	LITHASIA VERRUCOSA		33
KNOXVILLE	AMERICAN GINSENG	PANAX QUINQUEFOLIUS	S-CE	3334
KNOXVILLE	AMERICAN GINSENG	PANAX QUINQUEFOLIUS	S-CE	3334
KNOXVILLE	AMERICAN GINSENG	PANAX QUINQUEFOLIUS	S-CE	3334
KNOXVILLE	SPREADING ROCKCRESS	ARABIS PATENS	Z	31
KNOXVILLE	RUNTING BITTERCHES	CARDAMINE FLACILLIFERA	T	32
KNOXVILLE	APPALACHIAN BUCKWHEAT	CIMICIFUGA RUBIFOLIA	T	33
KNOXVILLE	GOLDENSEAL	HYDRASTIS CANADENSIS	S-CE	33
KNOXVILLE	GOLDENSEAL	HYDRASTIS CANADENSIS	S-CE	33
KNOXVILLE	CAREY'S SAXIFRAGE	SAXIFRAGA CAREYANA	3	33
KNOXVILLE	CAREY'S SAXIFRAGE	SAXIFRAGA CAREYANA	3	33
KNOXVILLE	CAREY'S SAXIFRAGE	SAXIFRAGA CAREYANA	3	33
KNOXVILLE	CAREY'S SAXIFRAGE	SAXIFRAGA CAREYANA	3	33

QUADNAME:..... SCONAME:..... NAME:..... FEDERAL STATE BRANK:.....

KNOXVILLE	CAREY'S SAXIFRAGE	SAXIFRAGA CAREYANA	S	33
KNOXVILLE	SPREADING FALSE-FOXGLOVE	AUREOLARIA PATULA	T	32
BEARDEN	BELLBENDER	CRYPTOBRANCHUS ALLEGANIENSIS	D	33
BEARDEN	TENNESSEE CAVE SALAMANDER	GYRINOPHILUS PALLIDUS	T	32
BEARDEN	RED-HEADED WOODPECKER	MELANERPES ERYTHROCEPHALUS		34
BEARDEN	SOUTHEASTERN SHREW	Sorex LONGIROSTRIS	D	34
BEARDEN	SOUTHEASTERN SHREW	Sorex LONGIROSTRIS	D	34
BEARDEN	GRAY BAT	MYOTIS GRISCEUS	LE	E 32

63 Records Processed




STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
401 Church Street
Nashville, Tennessee 37243

MEMORANDUM

DATE: October 6, 1997

TO: Andrew Barrass, Environmental Review Coordinator

FROM: David Duhi, Manager 
Tennessee Rivers Assessment Program

RE: Data Request for Smoky Mountain Smelter Site

A review of our database indicates that no information has been collected for surface waters in the area of interest.

Please let us know if we can be of help in a future request.

Federal Status Definitions of Tennessee's Rare Plants and Animals

Federally listed species are protected by the Endangered Species Act of 1973 (as amended) and the list is administered and determined by the US Fish and Wildlife Service.

E/SA - Endangered by similarity of appearance.

LE - **Listed Endangered**, the taxon is threatened by extinction throughout all or a significant portion of its range.

LT - **Listed Threatened**, the taxon is likely to become an endangered species in the foreseeable future.

PE - **Proposed Endangered**, the taxon is proposed for listing as endangered.

- **PT** - **Proposed Threatened**, the taxon is proposed to be listed as threatened.

Y - **Synonyms**

C - **Candidate Species**, These 'Candidate' species are not currently proposed for listing, but development and publication of proposed rules for such candidate species is anticipated. The US Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened species. The US Fish and Wildlife Service will determine the relative listing priority of these candidate species, and encourages other agencies, groups and individuals to give consideration to these taxa in environmental planning.

C2 - **DESIGNATION DISCONTINUED**

C3 - **DESIGNATION DISCONTINUED**

3A - **DESIGNATION DISCONTINUED**

3B - **DESIGNATION DISCONTINUED**

3C - **DESIGNATION DISCONTINUED**

__NL - status varies for different populations or parts of range with at least one part not listed.

__XN - non-essential experimental population

__XE - essential experimental population

(Modified From Federal Register, 50 CFR Part 17, Feb. 28, 1996, Vol. 61, No. 40, pp. 7596 - 7613.)

Note: The taxa listed as candidate species may be added to the list of Endangered and Threatened plants and animals, and, as such, consideration should be given them in environmental planning. Taxa listed as LE, LT, PE and PT must be given consideration in environmental planning involving federal funds, lands, or permits, and should be given consideration in all non-federal activities. For further information contact the Region 4, Endangered Species Coordinator, at the US Fish and Wildlife Service, 1875 Century Boulevard, Atlanta, Georgia 30345, phone (404)679-7096; or an Endangered Species Specialist at the US Fish and Wildlife Service, 446 Neal Street, Cookeville, Tennessee 38501, phone (615)528-6481.

State Status Definitions of Tennessee's Rare Plants

State Status indicates which plants are formally listed as state Endangered, Threatened, or Special Concern under the authority of the Tennessee Department of Environment and Conservation. The Department has the valuable assistance of the State's best field botanists, twelve of whom serve on the Scientific Advisory Committee which periodically reviews the list.

E - Endangered Species means any species or subspecies of plant whose continued existence as a viable component of the state's flora is determined by the Commissioner to be in jeopardy, including but not limited to all species of plants determined to be "endangered species" pursuant to the Endangered Species Act.

PE - Proposed Endangered means any species or subspecies of plant nominated by the Scientific Advisory Committee to be added to the list of Tennessee's Endangered Species. After approval by the commissioner of the Dept. of Environment & Conservation and the concurrence of the commissioner of Agriculture, these plants will formally become Endangered Species.

T - Threatened Species means any species or subspecies of plant which appears likely, within the foreseeable future, to become endangered throughout all or a significant portion of its range in Tennessee, including but not limited to all species of plants determined to be a "threatened species" pursuant to the Endangered Species Act.

S - Special Concern Species means any species or subspecies of plant which is uncommon in Tennessee, or has unique or highly specific habitat requirements or scientific value and therefore requires careful monitoring of its status.

State Status Modifiers follow State Status abbreviations.

P - Possibly Extirpated, species or subspecies that have not been seen in Tennessee for the past 20 years. May no longer occur in Tennessee.

CE - Commercially Exploited, due to large numbers being taken from the wild and propagation or cultivation insufficient to meet market demand. These plants are of long-term conservation concern, but the Division of Natural Heritage does not recommend they be included in the normal environmental review process.

(Adapted from Somers, Paul. 1989. Revised List of the Rare Plants of Tennessee. Journal of the Tennessee Academy of Sciences, 64(3): 179-184., and Rules of Tennessee Division of Ecological Services, Chap. 0400-6-2, Rare Plant Protection and Conservation Regulations.)

State Status Definitions of Tennessee's Rare Wildlife

State Status indicates which animals are formally listed as state endangered or threatened under the authority of the Tennessee Wildlife Resources Agency (T.C.A. 70-8-104, 70-8-105, and 70-8-107).

E - Endangered- any species or subspecies of wildlife whose prospects of survival or recruitment within the state are in jeopardy or are likely within the foreseeable future to become so due to any of the following factors:

- (a) The destruction, drastic modification, or severe curtailment of its habitat;
- (b) Its overutilization for scientific, commercial or sporting purposes;
- (c) The effect on it of disease, pollution, or predation;
- (d) Other natural or man-made factors affecting its prospects of survival or recruitment within the state; or
- (e) Any combination of the foregoing factors.

T- Threatened- any species or subspecies of wildlife which is likely to become an endangered species within the foreseeable future.

D - Deemed in Need of Management- any species or subspecies of nongame wildlife which the executive director of the TWRA believes should be investigated in order to develop information relating to population, distribution, habitat, needs, limiting factors, and other biological and ecological data to determine management measures necessary for their continued ability to sustain themselves successfully.

Species with no State Status designation are considered rare in the state by the Division of Natural Heritage. Information is collected on these species in order to minimize their formal listing as Endangered or Threatened.

NOTE: For further information contact the Tennessee Wildlife Resources Agency (TWRA) at (615)781-6670, or the Division of Natural Heritage at (615)532-0431. The USFWS has prime responsibility for federal status assignment and enforcement and protection of federally listed species. TWRA has responsibility for state status and enforcement and protection of state listed species.

As a supplement to the official State and Federal status (Tennessee Department of Environment & Conservation) determined using methodology developed by The Nature Conservancy based upon known occurrences of rare animals and published upon the best available information, with all State Ranks being which have neither federal nor state protected status are track Rank. In particular, these include species which are state endemics are facing particular threats, and for which neither state nor federal Ranks are defined as follows:

S1 = Critically imperiled in the state because of extreme rarity, vulnerable to extirpation from the state (Typically 5 or fewer occurrences).

S2 = Imperiled in the state because of rarity or because of so few from the state (6 to 20 occurrences or few remaining individuals).

S3 = Rare and uncommon in the state (21 to 100 occurrences).

S4 = Widespread, abundant, and apparently secure in state (Usually more than 100 occurrences).

S5 = Demonstrably widespread, abundant, and secure in state under present conditions.

SA = Accidental: Accidental or casual in the state (i.e., infrequent).

SH = Historical: Occurred historically in the state, and suspected to be extirpated.

SP = Potential: Potential that the species occurs in the state, but has not been reported.

SR = Reported: Reported in the state but without conclusive evidence accepting or rejecting (e.g., misidentified specimen) the report. Division of Natural Heritage does not have data to allow accurate ranking.

SSYN = Synonym: Reported from the state, but has been synonymized with another species.

SU = Unrankable: Possibly in peril in the state, but status uncertain.

SX = Extirpated: Believed to be extirpated from the state.

S#S# = Numeric range rank: A range between two of the numeric ranks.

S? = Unranked: Species not yet ranked in the state.

HYB = Hybrid: Taxon represents a hybrid between species.

B = Breeding: Considered a breeding population within the state.

N = Non-breeding: Considered a non-breeding population within the state.

? = Inexact or uncertain rank.

Note: DNH has responsibility for assigning state ranks to state endemics, and species with limited distribution in Tennessee for environmental planning. For further information contact DNH.

" Use Classifications for Surface Waters "

TDEC/Division of Water Pollution Control (DWPC). 1995. State of Tennessee Water Quality Standards, Chapter 1200-4-4, Use Classifications for Surface Waters. July. pp: 354-6.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

STATE OF TENNESSEE WATER QUALITY STANDARDS

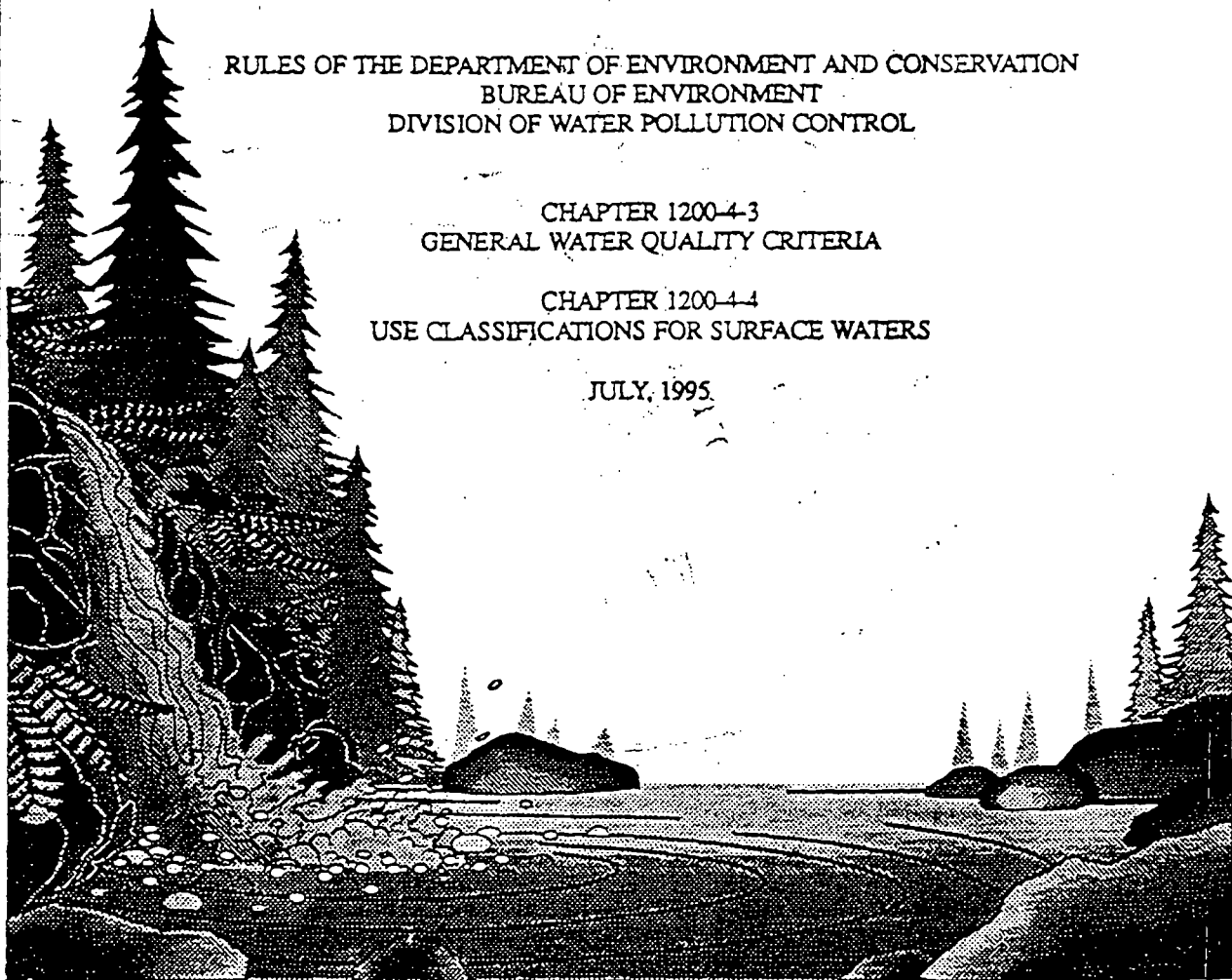


RULES OF THE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
BUREAU OF ENVIRONMENT
DIVISION OF WATER POLLUTION CONTROL

CHAPTER 1200-4-3
GENERAL WATER QUALITY CRITERIA

CHAPTER 1200-4-4
USE CLASSIFICATIONS FOR SURFACE WATERS

JULY, 1995



(Rule 1200-4-4-.01, continued)

(8) Upper Tennessee River Basin (cont.)

STREAM	DESCRIPTION	DOMESTIC WATER SUPPLY	INDUST WATER SUPPLY	FISH & AQUATIC LIFE	RECRE- ATION	IRRIG- ATION	LIVESTOCK WATERING & WILDLIFE	NAVIG- ATION	TROUT STREAM	NATURALLY REPRODUCING TROUT STREAM
Stony Branch	Mile 0.0 to Origin			X	X	X	X		X	
Arbutus Branch	Mile 0.0 to Origin			X	X	X	X		X	
Mill Creek	Mile 0.0 to Origin			X	X	X	X			X
Forge Creek	Mile 0.0 to Origin			X	X	X	X			X
Coalton Ground Br	Mile 0.0 to Origin			X	X	X	X		X	
Bower Creek	Mile 0.0 to Origin			X	X	X	X		X	
Tipton Sugar Cove	Mile 0.0 to Origin			X	X	X	X		X	
Ekanneetlee Br	Mile 0.0 to Origin			X	X	X	X		X	
Later Branch	Mile 0.0 to Origin			X	X	X	X		X	
McCaulley Branch	Mile 0.0 to Origin			X	X	X	X		X	
Rnwans Branch	Mile 0.0 to Origin			X	X	X	X		X	
Anthony Creek	Mile 0.0 to Origin			X	X	X	X			X
Shop Creek	Mile 0.0 to Origin			X	X	X	X		X	
Tabcat Creek	Mile 0.0 to Origin			X	X	X	X		X	
Parson Branch	Mile 0.0 to Origin			X	X	X	X			X
Bible Creek	Mile 0.0 to Origin			X	X	X	X		X	
Slickrock Creek	Tennessee portion			X	X	X	X		X	
Little Slickrock Cr	Mile 0.0 to Origin			X	X	X	X			X
Little Tennessee River	Mile 30.0 to 49.7 (IN - NC Line)	X	X	X	X	X	X		X	
Morgan Branch	Mile 0.0 to 0.8			X	X	X	X			
Morgan Branch	Mile 0.8 to 1.0			X	X	X	X			
Morgan Branch	Mile 1.0 to Origin			X	X	X	X			
Abrams Branch	Mile 0.0 to Origin			X	X	X	X			
First Creek	Mile 0.0 to Origin	X	X	X	X	X	X			
Tennessee River	Mile 601.1 to 636.6 (Little River)	X	X	X	X	X	X	X		
Town Creek	Mile 0.0 to Origin			X	X	X	X			
Gallagher Creek	Mile 0.0 to 3.3			X	X	X	X			
Gallagher Creek	Mile 3.3 to 3.5			X	X	X	X			
Gallagher Creek	Mile 3.5 to Origin			X	X	X	X			
Turkey Creek	Mile 0.0 to Origin			X	X	X	X			
Sinking Creek #1	Mile 0.0 to Origin	X	X	X	X	X	X			
Ten Mile Creek	From Sink to Origin			X	X	X	X			
Sinking Creek #2	Mile 0.0 to 0.7			X	X	X	X			
Sinking Creek #2	Mile 0.7 to 0.8			X	X	X	X			
Unnamed Trib	Mile 0.0 to 0.1			X	X	X	X			
Unnamed Trib	Mile 0.1 to Origin			X	X	X	X			
Sinking Creek #2	Mile 0.8 to Origin			X	X	X	X			
Lackey Creek	Mile 0.0 to Origin			X	X	X	X			
Unnamed Branch	Mile 0.0 to 0.5			X	X	X	X			
Unnamed Branch	Mile 0.5 to 0.7			X	X	X	X			
Unnamed Branch	Mile 0.7 to Origin			X	X	X	X			
Little River	Mile 0.0 to 33.0	X	X	X	X	X	X			
Polecat Branch	Mile 0.0 to 0.7			X	X	X	X			
Polecat Branch	Mile 0.7 to 0.8			X	X	X	X			
Polecat Branch	Mile 0.8 to Origin			X	X	X	X			
Stock Creek	Mile 0.0 to 3.2			X	X	X	X			
Stock Creek	Mile 3.2 to 3.4			X	X	X	X			
Stock Creek	Mile 3.4 to Origin			X	X	X	X			
McCall Branch	Mile 0.0 to 1.3			X	X	X	X			
McCall Branch	Mile 1.3 to 1.5			X	X	X	X			
McCall Branch	Mile 1.5 to Origin			X	X	X	X			
Russell's Branch	Mile 0.0 to Origin			X	X	X	X			

(Rule 1200-4-4-.01, continued)

(8) Upper Tennessee River Basin (cont.)

STREAM	DESCRIPTION	DOMESTIC WATER SUPPLY	INDUST WATER SUPPLY	FISH & AQUATIC LIFE	RECRE- ATION	IRRIG- ATION	LIVESTOCK WATERING & WILDLIFE	NAVIG- ATION	TROUT STREAM	NATURALLY REPRODUCING TROUT STREAM
Pistol Creek	Mile 0.0 to 0.1			X	X	X	X			
Pistol Creek	Mile 0.1 to 2.5			X	X	X	X			
Duncan Branch	Mile 0.0 to Origin			X	X	X	X			
Pistol Creek	Mile 2.5 to 6.6			X	X	X	X			
Culton Creek	Mile 0.0 to 0.4			X	X	X	X			
Tedford Br	Mile 0.0 to 0.4			X	X	X	X			
Tedford Br	Mile 0.4 to Origin			X	X	X	X			
Culton Creek	Mile 0.4 to Origin			X	X	X	X			
Pistol Creek	Mile 6.6 to 7.7			X	X	X	X			
Pistol Creek	Mile 7.7 to 8.0			X	X	X	X			
Pistol Creek	Mile 8.0 to 11.4			X	X	X	X			
Pistol Creek	Mile 11.4 to Origin			X	X	X	X			
Hesse Creek	Upper 5 miles			X	X	X	X		X	
Cane Creek	Upper 2.0 miles			X	X	X	X		X	
Beard Cane Cr	Upper 1.5 miles			X	X	X	X		X	
Little River	Mile 33.0 to Origin	X		X	X	X	X			X
M. Pr. Little River	Mile 0.0 to Origin			X	X	X	X			X
W. Prong Little R	Mile 0.0 to Origin			X	X	X	X		X	
Laurel Creek	Mile 0.0 to Origin			X	X	X	X		X	
Meadow Br	Mile 0.0 to Origin			X	X	X	X		X	
Spruce Flats Br	Mile 0.0 to Origin			X	X	X	X		X	
Sains Creek	Mile 0.0 to Origin			X	X	X	X		X	
Thunderhead Pr	Mile 0.0 to Origin			X	X	X	X		X	
Shut-in Cr	Mile 0.0 to Origin			X	X	X	X		X	
Lynn Camp Prong	Mile 0.0 to Origin			X	X	X	X		X	
Marks Creek	Mile 0.0 to Origin			X	X	X	X		X	
Meigs Creek	Mile 0.0 to Origin			X	X	X	X		X	
Little Greenbrier Creek	Mile 0.0 to Origin			X	X	X	X		X	
Mannis Branch	Mile 0.0 to Origin			X	X	X	X		X	
Blanket Creek	Mile 0.0 to Origin			X	X	X	X		X	
Shields Branch	Mile 0.0 to Origin			X	X	X	X		X	
Jakes Creek	Mile 0.0 to Origin			X	X	X	X		X	
Newl Prong	Mile 0.0 to Origin			X	X	X	X		X	
Laurel Branch	Mile 0.0 to Origin			X	X	X	X		X	
Fish Camp Prong	Mile 0.0 to Origin			X	X	X	X		X	
Gushen Prong	Mile 0.0 to Origin			X	X	X	X		X	
Silers Prong	Mile 0.0 to Origin			X	X	X	X		X	
Rich Branch	Mile 0.0 to Origin			X	X	X	X		X	
Rough Creek	Mile 0.0 to Origin			X	X	X	X		X	
Meigs Post Prong	Mile 0.0 to Origin			X	X	X	X		X	
Grouse Creek	Mile 0.0 to Origin			X	X	X	X		X	
Tennessee River	Mile 636.6 to 638.6	X	X	X	X	X	X	X		
Tennessee River	Mile 638.6 to 640.0		X	X	X	X	X	X		
Tennessee River	Mile 640.0 to 643.4	X	X	X	X	X	X	X		
Tennessee River	Mile 643.4 to 646.4		X	X	X	X	X	X		
Tennessee River	Mile 646.4 to 652.2	X	X	X	X	X	X	X		
Knob Creek	Mile 0.0 to Origin			X	X	X	X			
Flenniken Branch	Mile 0.0 to Origin			X	X	X	X			
Unnamed Branch	Mile 0.0 to 0.1			X	X	X	X			
Unnamed Branch	Mile 0.1 to Origin			X	X	X	X			
Unnamed Branch	Mile 0.0 to 1.1			X	X	X	X			
Unnamed Branch	Mile 1.1 to 1.3			X	X	X	X			
Unnamed Branch	Mile 1.3 to Origin			X	X	X	X			
Fourth Creek	Mile 0.0 to Origin			X	X	X	X			
Third Creek	Mile 0.0 to 4.9			X	X	X	X			

(Rule 1200-4-4-.01, continued)

(8) Upper Tennessee River Basin (cont.)

STREAM	DESCRIPTION	DOMESTIC WATER SUPPLY	INDUST WATER SUPPLY	FISH & AQUATIC LIFE	RECRE- ATION	IRRIG- ATION	LIVESTOCK WATERING & WILDLIFE	NAVIG- ATION	TROUT STREAM	NATURALLY REPRODUCING TROUT STREAM
Third Creek	Mile 4.9 to Origin	X	X	X	X	X	X			
Second Creek	Mile 0.0 to Origin		X	X	X	X	X			
First Creek	Mile 0.0 to Origin			X	X	X	X			

All other surface water named and unnamed in the Upper Tennessee River Basin, with the exception of wet weather conveyances, which have not been specifically noted shall be classified

X X X X

(9) Clinch River Basin

STREAM	DESCRIPTION	DOMESTIC WATER SUPPLY	INDUST WATER SUPPLY	FISH & AQUATIC LIFE	RECRE- ATION	IRRIG- ATION	LIVESTOCK WATERING & WILDLIFE	NAVIG- ATION	TROUT STREAM	NATURALLY REPRODUCING TROUT STREAM
Clinch River	Mile 0.0 to 4.4 (Emory River)	X	X	X	X	X	X	X		
Emory River	Mile 0.0 to Origin	X	X	X	X	X	X			
Little Emory River	Mile 0.0 to Origin	X	X	X	X	X	X			
Middle Fork Little Emory River	Mile 0.0 to Origin			X	X	X	X			
Davis Branch	Mile 0.0 to 0.2			X	X	X	X			
Unnamed Tributary	At Emory River (Mile 16.4), Mile 0.0 to 1.0			X	X	X	X			
Crooked Fork Creek	Mile 0.0 to 4.9			X	X	X	X			
Unnamed Tributary	At Crooked Fork Creek (Mile 4.9), Mile 0.0 to Origin			X	X	X	X			
Crooked Fork Creek	Mile 4.9 to 6.7	X		X	X	X	X			
Flat Fork Creek	Mile 0.0 to Origin	X		X	X	X	X			
Unnamed Tributary	At Flat Fork (Mile 2.3), Mile 0.0 to Origin			X	X	X	X			
Crooked Fork Creek	Mile 6.7 to Origin	X		X	X	X	X			
Stockstill Creek	Mile 0.0 to 0.4			X	X	X	X			
Stockstill Creek	Mile 0.4 to Origin			X	X	X	X			
Obed River	Mile 0.0 to 34.6			X	X	X	X			
Daddy's Creek	Mile 0.0 to Origin			X	X	X	X			
Basses Creek	Mile 0.0 to 6.0			X	X	X	X			
Basses Creek	Mile 6.0 to 6.2			X	X	X	X			
Basses Creek	Mile 6.2 to Origin			X	X	X	X			
Fox Creek	Mile 0.0 to Origin			X	X	X	X			
Scantling Branch	Mile 0.0 to 1.0			X	X	X	X			
Scantling Branch	Mile 1.0 to 1.2			X	X	X	X			
Unnamed Trib	At Scantling Branch (Mile 1.2), Mile 0.0 to Origin			X	X	X	X			
Scantling Branch	Mile 1.2 to Origin			X	X	X	X			
Unnamed Tributary	At Obed River (Mile 34.6), Mile 0.0 to 0.2			X	X	X	X			
Unnamed Tributary	Mile 0.2 to Origin			X	X	X	X			
Obed River	Mile 34.6 to 38.6			X	X	X	X			
Obed River	Mile 38.6 to 40.1			X	X	X	X			
Obed River	Mile 40.1 to Origin	X	X	X	X	X	X			
Unnamed Tributary	At Obed River (Mile 45.4), Mile 0.0 to Origin			X	X	X	X			
Clinch River	Mile 4.4 to 12.0 (Poplar Creek)	X	X	X	X	X	X	X		
Poplar Creek	Mile 0.0 to 0.5		X	X	X	X	X			
Poplar Creek	Mile 0.5 to 1.3			X	X	X	X			
Poplar Creek	Mile 1.3 to 5.5			X	X	X	X			
East Fork Poplar Creek	Mile 0.0 to 4.8			X	X	X	X			
Bear Creek	Mile 0.0 to Origin			X	X	X	X			
East Fork Poplar Creek	Mile 4.8 to 8.3			X	X	X	X			
East Fork Poplar Creek	Mile 8.3 to Dam at AEC Y-12			X	X	X	X			
Poplar Creek	Mile 5.5 to 12.4			X	X	X	X			

" Fishing Advisories "

TDEC/DWPC. 1996. Tennessee Fishing Advisories. Tennessee Department of Environment and Conservation. March 1992, revised May 1996.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

Why does the Department of Environment and Conservation issue advisories?

Tennessee issues advisories because, based on the best available research, there is an increased risk of cancer or other serious illness when concentrations of toxic materials exceed levels of concern. Children may be particularly vulnerable to these effects. The purpose of advisories is to give people the information they need so they can make informed choices.

Two types of fish advisories are issued. A **precautionary advisory**, the mildest form of advisory, warns children, pregnant women, and nursing mothers to avoid consumption of the type fish affected. All others are warned to limit consumption to 1.2 pounds per month.

A **no consumption advisory** warns the public to avoid eating a type of fish in any amount. In extreme cases, the Tennessee Wildlife Resources Agency can establish and enforce a sport or commercial fishing ban.

How do I know which areas are affected?

When the Department issues an **advisory** on a stream or lake, a press release concerning the nature of the health risk is issued. In most cases, signs warning the dangers of public use are placed at highly used access points. The Tennessee Wildlife Resources Agency also prints a list of the Department's advisories in the annual fishing regulations brochure.

If you are planning a fishing trip and have additional questions concerning advisories, feel free to call the Division of Water Pollution Control central office in Nashville (615-741-6623) or the field office in the area you are planning to fish. These telephone numbers

Nashville Central Office: - (615) 532 - 0699

Field Offices:

Johnson City - (423) 854 - 5400
Knoxville - (423) 594 - 6035
Chattanooga - (423) 634 - 5745
Nashville - (615) 650 - 7240
Jackson

What is the risk of eating fish where fishing advisories have been issued?

The risk of occasionally eating fish from one of these areas is small. Since cancer risk occurs over a lifetime of exposure, a few fish over a course of several years will not measurably increase your risk. However, children may be more susceptible to these materials and it is advised that children, pregnant women, and nursing mothers not eat fish from streams and lakes where a **precautionary advisory** or a **no consumption advisory** has been issued.

The risk can be reduced by taking a few simple precautions. Since these toxic materials are often associated with sediments, gamefish such as bass, bluegill, and crappie typically contain lower levels than do bottom-dwelling fish such as carp or catfish.

Although everybody likes to catch big fish, it's a simple fact that big fish tend to have higher levels of these materials than do smaller fish, because big fish are older and have had more time to accumulate toxic chemicals. Do not keep fish that appear to be in poor health.

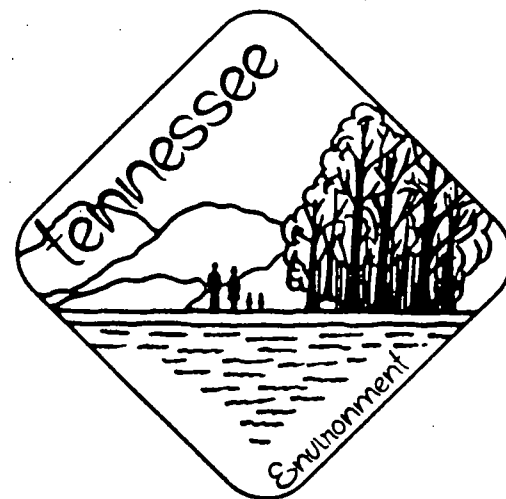
Since these materials accumulate in fatty tissues, when cleaning your catch, fish should be filleted and the skin removed. The belly flap and fatty strip along the backbone and lateral line should be discarded. Broiling, baking, or grilling fish provides additional risk reduction.

Contaminants are typically found in sediment and fish tissue and not in measurable levels in water. Treated water from these areas is certainly safe to drink. Swimming in these waters does not pose any additional health risk.



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TENNESSEE FISHING ADVISORIES



MARCH 1992

**TENNESSEE DEPARTMENT OF
ENVIRONMENT AND CONSERVATION**

**DIVISION OF WATER POLLUTION
CONTROL**

~~150 NINTH AVENUE, NORTH
NASHVILLE, TN 37243-4834~~

~~(615) 741-6602~~

WATER POLLUTION CONTROL
6th FLOOR L&C ANNEX
401 CHURCH STREET
NASHVILLE, TN 37243-4834

The Tennessee Department of Environment and Conservation is responsible for monitoring lakes and streams for toxic materials and for keeping the public informed about areas where sampling has shown that fish are affected.

The U.S. Food and Drug Administration and the U.S. Environmental Protection Agency determine acceptable levels of toxic chemicals in fish. Fortunately, most of Tennessee's fish are significantly below levels of concern and are safe to eat. There are currently 15 streams where fish tissue samples are known to be above levels of concern (see Table).

Fish contamination in many cases comes from a class of chemicals called polychlorinated biphenyls or PCBs. These chemicals were widely used in industrial and commercial equipment until their ban in 1976. Because of widespread use and their tendency to accumulate in fatty tissue, PCBs are routinely detected in fish samples from around the world. Although PCB levels are higher in lakes below large cities and other areas where extensive electrical equipment is used, the wind has also spread this chemical to remote lakes and streams.

Several streams are impacted by chlordane, a pesticide manufactured in Tennessee and, until recently, widely used around houses for termite control. One stream, the Pigeon River in East Tennessee, has been posted because of the presence of dioxin. Dioxin is not thought to be a widespread problem in Tennessee.

Two streams have been posted because of high levels of metals, including mercury.

The levels of toxic materials should be decreasing. Since the manufacture of the most dangerous of these chemicals has been halted and the others strictly regulated, levels should be decreasing nationwide. However, since these chemicals are often very stable and persistent and the levels found so small, it is not yet possible to confirm a decrease in our lakes and streams. Changes in levels of toxic materials will be more apparent from decade to decade than from year to year.

The Department of Environment and Conservation is committed to continue monitoring our lakes and streams and to keep the public

CURRENT FISH TISSUE ADVISORIES (February, 1992, This list subject to revision.)

STREAM	COUNTY	PORTION	POLLUTANT	TYPE ADVISORY
Loosahatchie River	Shelby	Mile 0.0-20.9	Chlordane	Fish should not be consumed.
Wolf River	Shelby	Mile 0.0-18.9	Chlordane	Fish should not be consumed.
Mississippi River	Shelby	MS line to mile 745	Chlordane	Fish should not be consumed. Commercial fishing ban.
McKellar Lake and Nonconnah Creek	Shelby	Mile 0.0 to 1.8. at Horn Lake Road bridge	Chlordane	Fish should not be consumed.
Boone Reservoir	Sullivan, Washington	Entirety	PCBs, chlordane	Precautionary advisory for carp and catfish.*
North Fork Holston River	Sullivan, Hawkins	Mile 0.0-6.2 TN/VA line	Mercury	Fish should not be consumed.
Woods Reservoir	Franklin	Entirety	PCBs	Catfish should not be consumed.
East Fork of Poplar Creek (incl. embayment)	Anderson, Roane	Mile 0.0 - 15.0	Mercury, metals, org. chemicals	Fish should not be consumed. Avoid contact with water.
Fort Loudoun Reservoir	Loudon, Knox, Blount	Entirety (46 miles)	PCBs	Commercial fishing for catfish prohibited. Catfish, largemouth bass over two pounds, and largemouth bass from the Little River embayment should not be consumed.
Tellico Lake	Loudon	Entirety	PCBs	Catfish should not be consumed.
Pigeon River	Cocke	N. Carolina line to Douglas Res.	Dioxin	Fish should not be consumed.
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tennessee River portion	PCBs	Catfish, striped bass, and hybrid striped bass-whitebass should not be consumed. Precautionary advisory* for whitebass, sauger, carp, smallmouth buffalo and largemouth bass.
	Roane, Anderson	Clinch River arm	PCBs	Striped bass should not be consumed. Precautionary advisory for catfish and sauger*.
Melton Hill Reservoir	Knox, Anderson	Entirety	PCBs	Catfish should not be consumed.
Chattanooga Creek	Hamilton	Mouth to GA line	PCBs, chlordane	Fish should not be consumed. Avoid contact with water.
Nickajack Reservoir	Hamilton, Marion	Entirety	PCBs	Precautionary advisory for catfish*.

* Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to 1.2 pounds per month.

CURRENT FISH TISSUE ADVISORIES (May, 1996, This list subject to revision.)

STREAM	COUNTY	PORTION	POLLUTANT	COMMENTS
Loosahatchie River	Shelby	Mile 0.0 - 20.9	Chlordane	Fish should not be consumed.
Wolf River	Shelby	Mile 0.0 - 18.9	Chlordane	Fish should not be consumed
Mississippi River	Shelby	MS line to mile 745	Chlordane	Fish should not be consumed. Commercial fishing ban.
McKellar Lake & Nonconnah Creek	Shelby	Mile 0.0 to 1.8	Chlordane	Fish should not be consumed. Advisory ends at Horn Lake Road bridge.
North Fork Holston River	Sullivan, Hawkins	Mile 0.0 - 6.2	Mercury	Fish should not be consumed. Advisory goes to TN/VA line.
East Fork of Poplar Creek (incl. embayment)	Anderson, Roane	Mile 0.0 - 15.0	Mercury, PCBs	Fish should not be consumed. Avoid contact with water also.
Chattanooga Creek	Hamilton	Mouth to GA line	PCBs, chlordane	Fish should not be consumed. Avoid contact with water also.
Woods Reservoir	Franklin	Entirety	PCBs	Catfish should not be consumed.
Fort Loudoun Reservoir	Loudon, Knox, Blount	Entirety (46 miles)	PCBs	Commercial fishing for catfish prohibited. Catfish, largemouth bass over two pounds, & any largemouth bass from the Little River embayment should not be consumed.
Tellico Lake	Loudon	Entirety	PCBs	Catfish should not be consumed.
Melton Hill Reservoir	Knox, Anderson	Entirety	PCBs	Catfish should not be consumed.
Watts Bar Reservoir	Roane, Meigs, Rhea, Loudon	Tn River portion	PCBs	Catfish, striped bass, & hybrid striped bass-white bass should not be consumed. Precautionary advisory* for whitebass, sauger, carp, smallmouth buffalo and largemouth bass.
Watts Bar Reservoir	Roane, Anderson	Clinch River arm	PCBs	Striped bass should not be consumed. Precautionary advisory for catfish and sauger.*
Boone Reservoir	Sullivan, Washington	Entirety	PCBs, chlordan	Precautionary advisory for carp and catfish.*
Nickajack Reservoir	Hamilton, Marion	Entirety	PCBs	Precautionary advisory for catfish.*
Pigeon River	Cocke	N. Carolina line to Douglas Res.	Dioxin	Precautionary advisory for carp, catfish, and redbreast sunfish.*

*Precautionary Advisory - Children, pregnant women, and nursing mothers should not consume the fish species named. All other persons should limit consumption of the named species to 1.2 pounds per month.

" Water Wells on the Knoxville Quadrangle "

TDEC/Division of Water Supply(DWS). 1997a. Records of Water Wells on the
Knoxville Quadrangle (0147NW) TN. November 12. Pp.:13-23.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NW 1 KNOX	09300190	RIDENOUR RACON VALLEY	R.B. 07/01/1965 / /	102 20	8 --	38 STEEL	-- -- --	GOOD	- - - -		00076 HOME
0147NW 1 KNOX	09301793	WILLIAMS GAP	WILL 12/12/1983 / /	625 160	4 117	83 STEEL	OPEN 83 - 625	OTHR	- - - -	Y	00383 HOME
0147NW 1 KNOX	09301999	CHANDLER GREENS WILSON	08/20/1987 / /	385 256	200 70	86 STEEL	OPEN 86 - 385	GOOD	- - - -	Y	00077 IRR
0147NW 1 KNOX	90000471	KNOXVILLE_RACQU LONAS	01/23/1989 / /	750 268	5 13	1239 STEEL	OPEN 124 - 750	OTHR	- - - -	Y	00385 IRR
0147NW 1 KNOX	93002882	FAULKNER I DUMER DR	ROBI 07/14/1993 / /	185 65	10 60	24 STEEL	OPEN 29 - 185	UNK	- - - -	Y	00684 HOME
0147NW 1 BLOUNT	93004741	MYERS TARKIN VALLEY R	JOHN 10/14/1993 4/18/1994	182 90	12 30	65 STEEL	OPEN 65 - 182	OTHR 005632	35-50-19 83-51-59	F Y	00385 HOME
0147NW 2 KNOX	09300015	STANLES KNITTING MI	10/17/1963 / /	500 200	130 30	19 STEEL	-- - --		35-57-43 83-55-21	S	00152 IND
0147NW 2 KNOX	09300167	THOMAS THOMAS WEAVER	J 05/15/1965 / /	415 400	13 --	30 STEEL	-- - --	GOOD	- - - -		00076 HOME
0147NW 2 KNOX	09301679	KNOXVILLE EXPO SITE/CLINC	CITY 12/17/1981 10/11/1983	197 85	-- 27	72 STEEL	OPEN 72 - 197	GOOD	35-57-44 83-55-25	S Y	00383 COMM
0147NW 2 KNOX	09301682	CONERGY_MARKET WORLD FAIR SITE	04/15/1982 10/11/1983	270 205	-- 60	40 STEEL	OPEN 40 - 270	GOOD	35-57-50 83-55-35	S Y	00383 COMM
0147NW 2 KNOX	09301973	RULE COVE POINT	JACK 03/26/1987 / /	350 135	60 100	-- STEEL	OPEN -- - --	GOOD	- - - -	Y	00152 HOME
0147NW 2 KNOX	09302146	GALYON ALVIN LANE	MIKE 04/29/1988 / /	130 100	90 15	41 STEEL	OPEN 41 - 130	GOOD	- - - -	Y	00264 HOME
0147NW 2 KNOX	09309032	ATLANTIC CO 0-38-38	/ /19 / /	365 --	460 13	100 STEEL	-- - --	GOOD	35-57-37 83-55-30	S	HOME
0147NW 2 KNOX	09309057	WINTER GARDEN 00174-	/ /19 / /	250 46	250 20	20 STEEL	-- - --	UNK	35-59-44 83-55-16	S	IND
0147NW 2 KNOX	09309058	WINTER GARDEN CO	/ /19 / /	400 --	60 40	20 STEEL	-- - --	UNK	35-59-44 83-55-16	S	IND
0147NW 2 KNOX	09309060	ROHN-HAAS 0-1760-17	/ /19 / /	160 --	100 34	20 STEEL	-- - --	UNK	36-03-52 84-04-48	S	IND

11/12/97

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TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NW 2 KNOX	90002791	REAGAN PAUL 523 WEST GLENDW	08/27/1990 / /	195 110	17 4	104 STEEL	OPEN 104 - 195	GOOD	- -	Y	00622 HOME
0147NW 2 KNOX	91001408	GERAGTTY & MILLER BROADWAY	01/19/1991 / /	20 5	-- --	-- OTHER	SCREEN 10 - 20	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	91001409	GERAGHTY & MILLER BROADWAY	01/19/1991 / /	20 --	-- --	-- OTHER	SCREEN 10 - 20	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	91001410	GERAGHTY & MILLER BROADWAY	01/19/1991 / /	20 --	-- --	-- OTHER	SCREEN 10 - 20	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	91001411	GERAGHTY & MILLER BROADWAY	01/16/1991 / /	20 --	-- --	-- OTHER	SCREEN 10 - 20	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	91001412	GERAGHTY & MILLER BROADWAY	01/16/1991 / /	50 45	2 15	40 STEEL	OPEN 40 - 50	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	91001413	GERAGHTY & MILLER BROADWAY	01/19/1991 / /	30 25	2 15	20 STEEL	OPEN 20 - 30	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	91001414	GERAGHTY & MILLER BROADWAY	01/19/1991 / /	30 25	2 15	20 STEEL	OPEN 20 - 30	OTHR	- -	Y	00264 MON
0147NW 2 KNOX	96004914 D0022209	BUSH MR. KINGSTON PIKE	10/12/1996 / /	583 215	60 --	170 STEEL	OPEN 170 - 583	OTHR	- -	Y	00385 HOME
0147NW 3 KNOX	09300135	COMBS K	10/24/1964 / /	100 30	10 30	45 STEEL	-- - --		- -		00031 HOME
0147NW 3 KNOX	09300179	WILLIAMS ROBE KODACK OFF 1MILE	05/28/1965 / /	190 180	20 90	34 STEEL	-- - --		- -		00152 HOME
0147NW 3 KNOX	09300209	SHARP H	/ /19 / /	160 30	3 --	52 STEEL	-- - --	GOOD	- -		00076 HOME
0147NW 3 KNOX	09300394	CURL KENN SPRINGTOWN	08/30/1967 / /	405 400	10 300	34 STEEL	-- - --	GOOD	- -		00264 FARM
0147NW 3 KNOX	09300553	JOE HOWELL NURSERY	02/01/1969 / /	720 146	35 120	84 STEEL	-- - --	GOOD	35-58-50 83-53-00	S	COMM
0147NW 3 KNOX	09300554	JOE HOWELL NURSERY	07/01/1969 / /	210 195	100 110	101 STEEL	148 - 152	GOOD	35-58-50 83-53-00	S	COMM
0147NW 3 KNOX	09300555	JOE HOWELL NURSERY	04/01/1969 / /	220 92	20 84	90 STEEL	-- - --		35-58-00 83-53-00	S	COMM

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE
QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NW 3 KNOX	09300556	JOE HOWELL NURSERY	09/01/1969 / /	300 150	20 --	90 STEEL	-- -- --	GOOD	35-58-50 83-53-00	S	COMM
0147NW 3 KNOX	09300557	JOE HOWELL NURSERY	11/01/1969 / /	220 --	4 90	88 STEEL	-- -- --	GOOD	35-58-00 83-53-00	S	COMM
0147NW 3 KNOX	09301983	(b) (6) (b) (6) NEUBERT SPGS RD	05/08/1987 / /	410 410	12 75	111 STEEL	OPEN 111 - 410	OTHR	- - - -	00660 Y	HOME
0147NW 3 KNOX	09309050	DIXIE LAUNDRY COMPA	/ /19 / /	201 --	350 20	22	-- -- --	UNK	35-57-40 83-54-21	S	IND
0147NW 3 KNOX	09309051	EAST TENN PACKING C	/ /19 / /	100 --	-- 45	--	-- -- --	UNK	35-57-33 83-54-31	S	IND
0147NW 3 KNOX	09309052	EAST TENN PACKING C	/ /19 / /	300 200	300 50	44 STEEL	-- -- --	UNK	35-57-33 83-54-31	S	IND
0147NW 3 KNOX	09309053	EAST TENN PACKING C	/ /19 / /	213 200	300 45	40 STEEL	-- -- --	UNK	35-57-33 83-54-31	S	IND
0147NW 3 KNOX	09309056	GRAY KNOX MARBLE CO	/ /19 / /	500 425	200 30	-- STEEL	-- -- --	UNK	35-57-32 83-56-52	S	IND
0147NW 3 KNOX	09309059	HOTEL FARRAGUT 0-17	/ /19 / /	765 --	80 90	110 STEEL	-- -- --	GOOD	35-57-52 83-55-05	S	IND
0147NW 3 KNOX	09309061	COCKRUM LUMBER 0-18	/ /19 / /	75 --	-- 25	--	-- -- --	GOOD	35-59-24 83-55-40	S	IND
0147NW 3 KNOX	09309062	TENN FLOORING 0-181	/ /19 / /	250 --	120 90	-- STEEL	-- -- --	UNK	35-59-30 83-54-39	S	IND
0147NW 3 SEVIER	15500789	FOX C	05/24/1968 / /	268 257	20 --	95 STEEL	-- -- --	GOOD	35-52-19 83-45-17	S	00152 FARM
0147NW 3 KNOX	91003387	APPALACHIAN FINISHI	07/17/1991 / /	465 160	60 12	102 STEEL	OPEN 102 - 465	OTHR	- - - -	00264 Y	HOME
0147NW 3 KNOX	91003388	APPALACHIAN FINISHI	07/10/1991 / /	830 300	10 6	90 STEEL	OPEN 90 - 830	OTHR	- - - -	00264 Y	HOME
0147NW 4 KNOX	09301559	K.M.C.COMPANY	12/04/1981 / /	165 146	60 90	72 STEEL	-- -- --	GOOD	35-56-46 83-56-06	S	00152 COMM
0147NW 4 KNOX	09302001	(b) (6) (b) (6) SOUTHERLAND AVE	07/16/1987 / /	185 160	12 92	59 STEEL	OPEN 59 - 185	GOOD	35-55-00 83-57-30	- Y	00077 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE
QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT. DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NW 4 KNOX	09309054	OGLE	W. B / /19	192 142	-- 62	80 STEEL	-- - --	GOOD	35-57-27 83-59-02	S	HOME
0147NW 4 KNOX	91003971	EYRING MD KINGSTON PK	EDWA 10/10/1991 / /	180 155	30 70	104 STEEL	OPEN 104 - 180	GOOD	- - - -		00692 IRR
0147NW 4 KNOX	92000969	JONES CRAIG COVE	BILL 05/13/1991 / /	442 235	80 90	109 STEEL	OPEN 109 - 442	UNK	- - - -		00385 HOME
0147NW 4 KNOX	93002051	(b) (6) 1100 TOBLER RD	(b) (6) L 04/26/1993 / /	200 165	10 50	125 STEEL	OPEN 125 - 200	GOOD	- - - -		00692 HOME
0147NW 5 KNOX	09300029	MAXWELL	08/29/1963 / /	182 --	-- 82	70 STEEL	-- - --	GOOD	35-55-09 83-55-06	S	00241 HOME
0147NW 5 KNOX	09300051	RICHARDS C	03/10/1964 / /	173 150	20 135	120 STEEL	-- - --	GOOD	35-54-25 83-55-50	S	00138 HOME
0147NW 5 KNOX	09301561	BECKER S.E.	02/08/1982 / /	185 115	60 50	73 STEEL	-- - --	GOOD	35-55-21 83-56-16	S	00152
0147NW 5 KNOX	09301562	SIMMONS H.	02/08/1982 / /	228 210	20 70	35 STEEL	-- - --	GOOD	35-55-22 83-56-15	S	00152
0147NW 5 KNOX	09301572	WIEGERS G.	01/06/1982 / /	300 --	10 90	186 STEEL	-- - --	GOOD	35-55-33 83-56-05	S	00138 HOME
0147NW 5 KNOX	09309029	CANDORS MABLEE0-44-	/ /19	380 --	350 65	10	-- - --	GOOD	35-55-57 83-55-08	S	IND
0147NW 5 KNOX	09309030	KNOX FERTILIZER 0-4	/ /19	700 --	100 300	--	-- - --	GOOD	35-55-12 83-55-33	S	IND
0147NW 5 KNOX	09309033	ROBERTSHAW-FULTON C	/ /19	505 --	500 35	--	-- - --	UNK	35-57-03 83-56-27	S	IND
0147NW 5 KNOX	09309034	ROBERTSHAW-FULTON C	/ /19	305 250	250 35	--	-- - --	GOOD	35-57-03 83-56-27	S	OTHR
0147NW 5 KNOX	09309035	ROGERS W R 0-360-36	/ /19	121 80	-- 44	40	-- - --	GOOD	35-55-18 83-56-02	S	HOME
0147NW 5 KNOX	09309041	WILSON W A 0-23 0-2	00/19/1936 / /	104 --	-- 14	104	-- - --	GOOD	35-55-09 83-55-45	S	HOME
0147NW 5 KNOX	09309044	DUNFORD R E 0-120-1	/ /19	71 --	-- 35	--	-- - --	GOOD	35-55-33 83-57-15	S	HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NW 5 KNOX	91000203	(b) (6) _____ TIPTON STA RD	(b) (6) 07/05/1990 / /	225 90	12 70	42 STEEL	OPEN -- --	OTHR --	-- --	Y	00152 HOME
0147NW 5 KNOX	92004076	(b) (6) _____ MT OLIVE RD	(b) (6) 05/20/1988 / /	465 --	7 135	147 STEEL	OPEN 47 - 465	UNK --	-- --	Y	00385 HOME
0147NW 6 KNOX	09300016	JONES K	10/12/1963 / /	135 100	10 50	25 STEEL	-- --	--	35-57-25 83-53-20	S	00152 HOME
0147NW 6 KNOX	09300042	MCLANHAN J	01/31/1964 / /	120 100	-- 90	74 STEEL	-- --	GOOD	35-55-31 83-53-10	S	00031 HOME
0147NW 6 KNOX	09301535	REAGAN B.	07/11/1981 / /	280 260	15 80	72 STEEL	-- --	--	36-57-12 83-45-54	S	00138 HOME
0147NW 6 KNOX	09301699	HARRIS _____ VIGE MARTIN MILL PK	09/01/1983 / /	228 150	-- 140	68 STEEL	OPEN 68 - 228	GOOD	35-55-00 83-50-00	M Y	00152 HOME
0147NW 6 KNOX	09301846	SMITH _____ JAME BURNETTS CREEK	11/28/1985 / /	210 210	10 30	30 STEEL	OPEN 30 - 210	OTHR --	-- --	Y	00115 HOME
0147NW 6 KNOX	09302028	GLEEN _____ MICK MIDWAY RD OF 14	10/17/1987 / /	225 201	5 85	39 STEEL	OPEN 39 - 225	GOOD	-- --	Y	00031 HOME
0147NW 6 KNOX	09302029	(b) (6) _____ (b) (6) MCCUBINS RD	09/24/1987 / /	210 180	10 70	105 STEEL	OPEN 105 - 210	GOOD	-- --	Y	00031 HOME
0147NW 6 KNOX	09302030	THORNHILL _____ MARI STRAW PLAIN PK	09/24/1987 / /	145 121	5 40	19 STEEL	OPEN 19 - 145	GOOD	-- --	Y	00031 HOME
0147NW 6 KNOX	09302031	GALLESPIE _____ FRED TUCK-HOE RD NEA	08/14/1987 / /	168 168	11 75	20 STEEL	OPEN 20 - 168	GOOD	-- --	Y	00031 HOME
0147NW 6 KNOX	09309027	NELSON L 0-1510-151	00/19/1940 / /	168 --	-- --	-- --	-- --	GOOD	35-56-30 83-52-52	S	HOME
0147NW 6 KNOX	09309028	FRANKLIN H B	/ /19 / /	120 --	-- 45	20 --	-- --	GOOD	35-54-42 83-54-21	S	HOME
0147NW 6 KNOX	90000483	JOHNSON _____ CO LOCUST HILL	3/ 7/1990 / /	-- 394	70 --	315 STEEL	OPEN -- --	OTHR 315	-- --	Y	00385 IRR
0147NW 6 KNOX	90000726	(b) (6) _____ (b) (6) BLAZIER RD	02/15/1990 / /	662 189	3 3	62 STEEL	OPEN 62 - 662	OTHR --	-- --	Y	00385 HOME
0147NW 6 KNOX	92004272	BLALOCK _____ JIM MARTIN MILL PK	11/14/1992 / /	530 130	25 120	42 STEEL	OPEN 42 - 530	UNK --	-- --	Y	00684 HEAT

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NW 6 KNOX	97000439 D0019300	(b) (6) S _____ (b) (6) BERRY RD	01/23/1997 / /	190 150	8 50	63 STEEL	OPEN 63 - 190	GOOD	- - - -	- Y	00667 HOME
0147NW 7 BLOUNT	00901338	CRAIG _____ MRS BEAR HOLLOW	05/16/1985 / /	245 80	8 20	42 STEEL	OPEN 42 - 245	OTHR	- - - -	- Y	00383 HOME
0147NW 7 KNOX	09300002	SCHRIEVER W	06/24/1963 / /	430 400	6 150	87 STEEL	- - - -	-	35-53-57 83-59-36	S	00138
0147NW 7 KNOX	09300086	ROSCH N	07/28/1964 / /	450 445	10 100	73 STEEL	- - - -	-	35-54-03 83-59-13	S	00152 HOME
0147NW 7 KNOX	09300434	WARE DUNCAN	09/12/1968 / /	200 185	15 65	64 STEEL	- - - -	GOOD	- - - -	-	00385 HOME
0147NW 7 KNOX	09301708	MORRIS _____ ROBE DUNCAN	10/25/1983 / /	455 380	45 280	97 STEEL	OPEN 97 - 455	GOOD	35-53-37 83-59-52	S Y	00152 HOME
0147NW 7 KNOX	09301784	SMITH _____ DAVI LIONS BEND	11/14/1984 / /	170 145	12 50	55 STEEL	OPEN 55 - 170	OTHR	- - - -	- Y	00264 HOME
0147NW 7 KNOX	09301885	SOSS _____ SHEL RIO VISTA LN	05/16/1986 / /	475 285	20 --	150 STEEL	OPEN -- - -	GOOD	- - - -	- Y	00581 IRR
0147NW 7 KNOX	09301965	PYLE _____ MIKE TOPSIDE	05/15/1986 / /	200 165	15 --	42 STEEL	OPEN 42 - 200	GOOD	- - - -	- Y	00581 HOME
0147NW 7 KNOX	09309025	DAVIS HOWELL J 0-B1	/ /19 / /	97 --	-- --	-- --	-- -- - -	GOOD	35-54-52 83-59-03	S	HOME
0147NW 7 KNOX	09309026	TAYLOR GEORGE P 0-2	/ /19 / /	-- --	-- --	-- --	-- -- - -	GOOD	35-54-58 83-59-37	S	HOME
0147NW 7 KNOX	09309045	HERTED K L 0-10 0-1	/ /19 / /	151 --	3 41	-- --	-- -- - -	GOOD	35-54-53 83-58-18	S	HOME
0147NW 7 KNOX	09309046	DUNCAN B. F	/ /19 / /	100 --	-- 16	35 --	-- -- - -	GOOD	35-53-22 83-59-18	S	HOME
0147NW 7 KNOX	09309047	HOUSE J. W	/ /19 / /	125 --	-- 60	-- --	-- -- - -	GOOD	35-53-07 83-58-08	S	HOME
0147NW 7 KNOX	90000479	ALCORN _____ TOPSIDE RD	06/26/1989 / /	225 195	60 8	83 STEEL	OPEN 83 - 225	OTHR	- - - -	- Y	00385 HOME
0147NW 7 BLOUNT	90003397	WHITEHEAD _____ DORI LANDING LANE	08/02/1990 / /	150 60	60 40	38 STEEL	OPEN 38 - 150	OTHR	- - - -	- Y	00383 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE
QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NW 7 KNOX	92003860	PHILLIPS CONSTRUCTI RUDDER LANE	09/04/1992 / /	225 210	20 80	157 STEEL	OPEN 157 - 225	OTHR	- - - -	- Y	00608 HOME
0147NW 7 BLOUNT	95000558 D0002871	LAWLER _____ RODN BEAR HOLLOW	01/20/1995 / /	410 406	80 225	105 STEEL	OPEN 105 - 410	OTHR	- - - -	- Y	00383 FARM
0147NW 7 KNOX	95003758 D0011521	(b) (6) _____ (b) (6) BLUE RIDGE DR	08/02/1995 / /	610 220	12 100	84 STEEL	OPEN 84 - 610	OTHR	- - - -	- Y	00383 HOME
0147NW 7 KNOX	95004556 D0007907	(b) (6) _____ (b) (6) DUNCAN ROAD	09/15/1995 / /	660 400	5 --	187 STEEL	OPEN 187 - 660	OTHR	- - - -	- Y	00385 HOME
0147NW 7 KNOX	95004557 D0007905	(b) (6) _____ (b) (6) RIVERGATE RD	09/12/1995 / /	180 142	50 50	62 STEEL	OPEN 62 - 180	OTHR	- - - -	- Y	00385 HOME
0147NW 7 KNOX	95005532 D0016353	ADAMS _____ COY TIPTON STATION	09/26/1995 / /	425 350	6 120	62 STEEL	OPEN 62 - 425	UNK	- - - -	- Y	00536 HOME
0147NW 8 KNOX	09300069	CLARK HOME BUILDERS	05/30/1964 / /	100 --	-- 60	28 STEEL	-- - --	GOOD	35-53-43 83-55-45	S	00241 HOME
0147NW 8 KNOX	09300114	ROBERTS E	07/22/1964 / /	137 78	10 60	63	-- - --		35-54-08 83-55-10	S	00031 HOME
0147NW 8 KNOX	09300431	EVANS A	08/02/1968 / /	333 320	13 175	8 STEEL	-- - --	GOOD	35-54-40 83-55-45	S	00385 HOME
0147NW 8 KNOX	09300443	NORRIS F	09/28/1968 / /	216 195	25 --	50 STEEL	-- - --		35-53-58 83-55-55	S	00138
0147NW 8 KNOX	09301638	U T #1	10/09/1982 / /	60 52	7 30	40 STEEL	-- - --	GOOD	35-54-08 83-57-16	S	00385
0147NW 8 KNOX	09301639	U T #1A	01/03/1983 / /	60 54	7 30	42 STEEL	-- - --	GOOD	35-54-08 83-57-16	F	00385
0147NW 8 KNOX	09301640	U T #1B	/ /19 / /	60 51	8 --	42 STEEL	-- - --	GOOD	35-54-09 83-57-16	F	00385
0147NW 8 KNOX	09301641	U T #1C	/ /19 / /	60 --	-- --	42 STEEL	-- - --		35-54-07 83-57-15	F	00385
0147NW 8 KNOX	09301642	U T #1D	/ /19 / /	60 --	-- --	44 STEEL	-- - --		35-54-08 83-57-16	F	00385
0147NW 8 KNOX	09301643	U T #2	/ /19 / /	70 63	10 35	52 STEEL	-- - --	GOOD	35-54-08 83-57-14	F	00385

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE QUADRANGLE (0147NW) TN..

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C DRILLER LOG USE
0147NW 8 KNOX	09301644	U T #2A	/ /19 / /	100 --	-- 35	47 STEEL	-- - --		35-54-08 83-57-16	M 00385
0147NW 8 KNOX	09301645	U T #3	/ /19 / /	100 65	7 30	44 STEEL	-- - --	GOOD	35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301646	U T #3A	/ /19 / /	100 --	-- 30	46 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301647	U T #3B	/ /19 / /	100 --	-- 30	44 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301648	U T #3C	/ /19 / /	100 --	-- 30	42 STEEL	-- - --		35-54-08 83-57-17	F 00385
0147NW 8 KNOX	09301649	U T #3D	/ /19 / /	100 --	-- 30	42 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301650	U T #3E	/ /19 / /	100 --	-- 30	42 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301651	U T #3F	/ /19 / /	100 --	-- 30	43 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301652	U T #3G	01/05/1983 / /	100 --	-- 35	42 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301653	U T #4	/ /19 / /	80 75	13 --	51 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301654	U T #5	/ /19 / /	90 80	12 30	61 STEEL	-- - --	GOOD	35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301655	U T #5A	/ /19 / /	100 --	-- --	42 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301656	U T #6	/ /19 / /	60 --	-- --	61 STEEL	-- - --		35-54-08 83-57-16	F 00385
0147NW 8 KNOX	09301676	KEENER III SAM CRENSHAW	03/30/1983 07/28/1983	300 185	25 160	63 STEEL	OPEN 63 - 300	GOOD	35-53-25 83-55-18	S 00152 Y HOME
0147NW 8 KNOX	09301697	KNIGHT HERB TIPTON STATION	08/03/1983 / /	125 --	-- 60	68 STEEL	OPEN 68 - 125	OTHR	35-50-00 83-55-00	M 00365 N HOME
0147NW 8 KNOX	09301960	HURST J_C OLD MARYVILLE P	02/12/1987 / /	240 220	10 --	60 STEEL	OPEN 60 - 240	OTHR	- - - -	00138 Y OTHR

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE KNOXVILLE
QUADRANGLE (0147NW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C DRILLER LOG USE
0147NW 8 KNOX	09302087	(b) (6) _____ (b) (6) TOOLS BEND RD	04/16/1988 / /	210 190	12 100	167 STEEL	OPEN 167 - 210	GOOD	- - - -	00536 Y HOME
0147NW 8 KNOX	09309036	NEAS MARK 0-35 0-3	00/19/1928 / /	47 --	-- 12	10	-- - --	GOOD	35-54-04 83-56-19	S HOME
0147NW 8 KNOX	09309037	HARRISON WALLACE 03	/ /19 / /	165 --	-- 65	70	-- - --	GOOD	35-53-05 83-56-18	S HOME
0147NW 8 KNOX	09309038	DAVIS P H 0-28-128-	00/19/1943 / /	135 80	-- 25	70	-- - --	GOOD	35-54-03 83-57-05	S HOME
0147NW 8 KNOX	09309039	ELLIOTT BILL 0-26-2	00/19/1943 / /	78 --	-- 5	40	-- - --	GOOD	35-54-49 83-56-46	S HOME
0147NW 8 KNOX	09309040	KING O M 0-24	/ /19 / /	165 --	-- 40	35	-- - --	GOOD	35-54-49 83-56-46	S HOME
0147NW 8 KNOX	09309042	DEMPSTER J 0-20 0-2	/ /19 / /	125 --	-- 35	30	-- - --	GOOD	35-54-26 83-54-23	S HOME
0147NW 8 KNOX	09309043	GINN A A 0-19 0-1	/ /19 / /	95 --	-- 40	16	-- - --	GOOD	35-54-22 83-57-27	S HOME
0147NW 8 BLOUNT	94003853 D0002865	(b) (6) _____ (b) (6) CUB RD	10/04/1994 / /	230 220	15 20	42 STEEL	OPEN 42 - 230	OTHR	- - - -	00383 Y HOME
0147NW 8 KNOX	94004026 D0000000	BAGWELL COMMUNICATI	09/17/1994 / /	550 115	100 32	85 STEEL	OPEN 85 - 550	GOOD	- - - -	00385 Y IRR
0147NW 8 KNOX	94004027 D0000000	(b) (6) _____ (b) (6) SMOKY VIEW RD	08/15/1994 / /	350 250	60 45	106 STEEL	OPEN 106 - 350	GOOD	- - - -	00385 Y HOME
0147NW 9 KNOX	09300298	PERDIGO P	10/28/1966 / /	434 432	11 --	353 STEEL	-- - --	GOOD	35-54-20 83-54-22	S HOME
0147NW 9 KNOX	09300299	DAVIS T	10/07/1966 / /	251 246	16 --	63 STEEL	-- - --	BAD	35-54-08 83-54-30	S HOME
0147NW 9 KNOX	09300361	WALKER C	09/22/1967 / /	410 402	40 --	226 STEEL	-- - --	GOOD	35-54-20 83-53-00	S HOME
0147NW 9 KNOX	09300644	BEELE H MT OLIVE	05/11/1971 / /	155 145	19 80	95 STEEL	-- - --		- - - -	00152 HOME
0147NW 9 KNOX	09301231	MICHEL S GODDARD	JIM 07/10/1978 / /	169 100	50 35	31 STEEL	-- - --	GOOD	35-52-44 83-54-20	S HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
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QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NW 9 KNOX	09301482	ROSE R	00/00/1981 / /	120 100	50 30	47 STEEL	-- -- --	GOOD	-- --		00138 HOME
0147NW 9 KNOX	09301538	TODDY K.	07/29/1981 / /	500 485	30 200	21 STEEL	-- -- --		35-54-10 83-54-30	S	00138 HOME
0147NW 9 KNOX	09301555	WILLIAMS W.	06/25/1981 / /	392 365	13 100	105 STEEL	-- -- --		35-54-25 83-54-30	S	00385 HOME
0147NW 9 KNOX	09301613	BRIGHT MR. T	07/28/1982 / /	125 95	30 --	81 STEEL	-- -- --	GOOD	35-53-50 83-53-41	S	00385 HOME
0147NW 9 KNOX	09301617	METHANY PHIL	09/11/1982 / /	210 204	7 50	61 STEEL	-- -- --	GOOD	35-53-57 83-53-39	S	00385 HOME
0147NW 9 KNOX	09301764	STINNETT _____ SYLV TWIN CREEK RD	04/16/1984 03/10/1986	160 100	30 30	-- STEEL	OPEN -- -- --	GOOD	36-50-00 83-55-00	T Y	00385 HOME
0147NW 9 KNOX	09301964	OLIVER _____ MARI TWIN CREEK RD	04/14/1987 / /	134 70	50 48	53 STEEL	OPEN 53 - 134	GOOD	- - - -		00622 HOME
0147NW 9 KNOX	09309031	EASGLOR H L 0-41-41	/ /19 / /	190 --	-- 60	--	-- -- --	GOOD	35-54-56 83-54-38	S	HOME
0147NW 9 KNOX	09309048	BAKER D.	/ /19 / /	152 --	20 11	40	-- -- --	UNK	35-52-50 83-54-56	S	HOME
0147NW 9 KNOX	09309049	CAGLE MANL	/ /19 / /	94 --	20 24	40 STEEL	-- -- --	GOOD	35-53-04 83-54-31	S	HOME
0147NW 9 KNOX	90000470	MAYES _____ DR	10/ 1/1988 / /	561 63	60 5	-- STEEL	OPEN 57 - 561	UNK	- - - -		00385 HOME
0147NW 9 KNOX	90000480	COSTNER _____ ERNE HARRIS LN	07/25/1989 / /	241 78	22 3	62 STEEL	OPEN 62 - 241	OTHR	- - - -		00385 HOME
0147NW 9 KNOX	90000725	STINNETT _____ MRS TWIN CREEK RD	02/06/1990 / /	141 126	14 3	62 STEEL	OPEN 62 - 141	OTHR	- - - -		00385 HOME
0147NW 9 KNOX	90002339	BLAZIER _____ DAVI	06/01/1990 / /	650 400	2 20	315 STEEL	OPEN 315 - 650	OTHR	- - - -		00264 HOME
0147NW 9 KNOX	90002358	BLAZIER _____ DAVI	06/01/1990 / /	650 400	2 20	315 STEEL	OPEN 315 - 650	OTHR	- - - -		00264 HOME
0147NW 9 KNOX	91000813	CLARK _____ W_C	02/23/1991 / /	345 345	7 50	125 STEEL	OPEN -- - 125	GOOD	- - - -		00264 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
 RECORDS OF WATER WELLS ON THE KNOXVILLE QUADRANGLE (0147NW) TN.

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0147NW 9 KNOX	93002835	(b) (6) _____ (b) (6) BLAZER RD	06/28/1993 4/26/1994	225 170	100 105	82 STEEL	OPEN 82 - 225	OTHR 008297	35-51-37 83-52-19	S Y	00264 IRR
0147NW 9 KNOX	93002836	(b) (6) _____ (b) (6) BLAZER RD	06/24/1993 4/26/1994	525 465	-- 200	285 STEEL	OPEN 285 - 525	OTHR 008296	35-51-00 83-52-19	S Y	00264 HOME
0147NW 9 KNOX	93002837	(b) (6) _____ (b) (6) BLAZER RD	06/25/1993 4/26/1994	340 325	40 200	119 STEEL	OPEN 119 - 340	OTHR 008298	35-50-54 83-52-18	S Y	00264 HOME
0147NW 9 KNOX	95003547 D0011953	FRYE _____ ROEE NEUBERT SPRINGS	07/19/1995 / /	425 135	3 115	82 STEEL	OPEN 82 - 425	GOOD	- - - -	- - Y	00622 HOME
0147NW 9 KNOX	96002621 D0016887	POSTOW _____ BETS TIPTON STATION	05/13/1996 / /	200 50	60 40	21 STEEL	OPEN 60 - 200	OTHR	- - - -	- - Y	00385 HOME

" Field/Activity Report "

TDHE/Division of Solid Waste Management (DSWM). 1983. "Field/Activity Report", by J. Crabtree (DSWM), dated March 23.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

Q-7 3-25-83

DIVISION OF SOLID WASTE MANAGEMENT
FIELD/ACTIVITY REPORT

Name of Facility and Owner Rotary Furnace Inc., Smokey Mountain Smelters, Inc.,
and David Witherspoon Inc.

Type of Facility Industrial

County Knox City Knoxville Date 3/23/83

Individuals Contacted Dan E. Johnson, President, Smokey Mountain Smelters, Inc.,
David Witherspoon, President, David Witherspoon Inc., Mark Burris, Engineer (DSWM),
Fred Russell, plant employee, Rotary Furnace Inc.

Report (Purpose of visit, activities)

The Division received a call from William Schaad of the Knox County Air Pollution Control office stating that Smokey Mountain Smelters Inc., Rotary Furnace Inc., and David Witherspoon Inc., were operating a landfill on old Maryville Pike on property where the Agrico Fertilizer Plant used to be located. Witherspoon Inc. is now the owner of this property and Smokey Mountain Smelters Inc. and Rotary Furnace Inc. are operating at the plant site.

Mark Burris, Engineer, and writer investigated and found a considerable amount of demolition and industrial waste and evidence that a fire had recently occurred at the site. There was evidence of clay soil being moved to put out the fire as part of the dump was covered. On top of the dump there was tons of slag and cinders from the furnace operations. We talked briefly at the furnace site with Mr. Fred Russell and then drove to Mr. Johnson's and Witherspoon's office, approximately 1/4-mile away from the site on Old Maryville Pike.

Mr. Burris and writer met with Mr. Johnson and Mr. Witherspoon and discussed the permit requirements for a demolition, industrial landfill and the steps required for permitting. We advised Mr. Johnson and Mr. Witherspoon to cease dumping at the unregistered site until a permit was obtained. Alternative registered sites were given to Mr. Johnson that may be selected for waste disposal.

Mr. Witherspoon stated that the slag material on site was not waste but was going to be reused in the future. He stated that the material was being stored on-site for future use. Mr. Burris and writer questioned this response since a very similar industry in an adjacent county is landfilling very similar material (Metal Resources Inc., Loudon County).

A NOTICE OF VIOLATION will be issued to Mr. Witherspoon for operating without a permit. Also, clarification and a decision from the Division of Solid Waste Management relative to the slag material will be made.



Jack Crabtree, Environmental Consultant
Division of Solid Waste Management

JPC/ekj

cc: Bobby Morrison, Division of Solid Waste Management-Nashville
TDPH-SWM
B-062 (Rev.5/77)

" Report of Geologic Investigation "

TDHE/DSWM. 1983. "Report of Geologic Investigation", by G. Pruitt (DSWM),
dated November 4.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



STATE OF TENNESSEE
DEPARTMENT OF HEALTH AND ENVIRONMENT
EAST TENNESSEE REGIONAL OFFICE
ALEX B. SHIPLEY REGIONAL HEALTH CENTER
1522 CHEROKEE TRAIL
KNOXVILLE, TENNESSEE 37920

November 4, 1983

REPORT OF GEOLOGIC INVESTIGATION

Subject: Knox County, Smoky Mountain Smelters, Inc. - Geologic Evaluation of a Proposed "Industrial Storage Yard."

Date of Visit: August 30, 1983, with Mr. J. P. Crabtree of DSWM and with Mr. Dan E. Johnson representing the applicant.

Location: Quadrangle 147-NW, Knoxville. This site is located about 3 miles south from the center of Knoxville and is on the east side of Maryville Pike (TN 33). A location map is attached.

Property Description: Smoky Mountain Smelters appears to be mainly a reclamation or "resource recovery" operation, reclaiming and processing scrap aluminum into ingots of aluminum or alloys thereof. The subject site is comprised of about 3 acres (±) which lie adjacent to and southwest of the smelter facility.

The site has the appearance of a dump, containing mostly an impure "salt cake" which has resulted from the processing of aluminum ore. The company is said to be storing this salt cake for eventual reclamation and resale, and company personnel have indicated that the subject area is a storage area and not a disposal facility. However, a very small quantity of demolition-type waste was observed here such as old air conditioner parts, pasteboard cartons, and some assorted wood and metal debris. A rough earthen dike has been placed around the downgradient sides of the amassed salt cake and this seems to effectively control surface drainage away from the area.

No putrescible waste was observed here. Two old (?) settling ponds are situated just to the east of the subject site.

Topography and Drainage: The subject site is on generally low and rolling land which slopes very gently to the southwest. Surface runoff flows generally southwestward to an unnamed and partially intermittent drainway and thence to the Knob Creek embayment of the Fort Loudon Reservoir about 2 miles to the southwest. No streams or springs were observed on the site.

No depressions or sinks were observed on this site.

Geology: This site is underlain by the Ottosee shale which in this area is mainly a brown or grayish silty shale with interbedded calcareous shale. Limestone lenses or beds may occur within the Ottosee but none were apparent at this facility. No bedrock outcrops were observed.

Structurally, this area is situated over the southeast limb of a northeast trending synclinal flexure. The structural setting implies that the bedrock will be jointed; however, there are no surface indications of structural influence. Joints in the shale phases of the Ottosee will tend to be tight and relatively unaffected by solutional weathering.

The Ottosee weathers to a relatively thin, yellowish brown or tan, silty soil which grades progressively into weathered shale and shale bedrock. These soils may have a "chippy" texture due to abundance of small shale fragments. Soil development may be deeper in areas of more intense structural deformation.

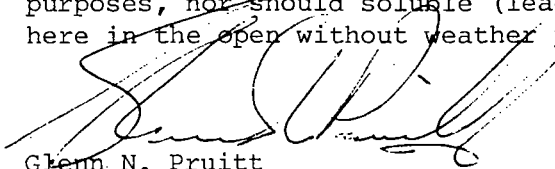
Groundwater Hydrology: Groundwater storage and movement in the shale portions of the Ottosee are restricted to tight joints and bedding planes; however, as the carbonate content increases, the secondary porosity may have been substantially enhanced by solutional activity and the unit may then contain significant amounts of groundwater. Also, in areas of intense deformation, the effects of "crumpling" and shearing may have increased the aquifer potential of the Ottosee. However, with some few exceptions, there are relatively few high yield wells and springs in the Ottosee shale, although there is generally sufficient yield for domestic water supplies.

The Ottosee soils here appear to be somewhat permeable. During periods of heavy rainfall water may percolate fairly rapidly to the more impermeable shale substrate and then flow laterally downgradient to form seeps or "wet weather" springs in nearby drainages.

Conclusions and Recommendations: This site does not have sufficient geologic potential for the disposal of either putrescible or leachable wastes. There appears to be insufficient soil development here to allow for an effectual sorptive buffer above bedrock and/or groundwater. Any leachate occurring here is likely to percolate more or less directly to bedrock, and while some contamination of groundwater would be almost a certainty, there is the eminent probability of lateral seepage and the eventual pollution of surface water.

The salt cake material "stored" here appears to consist largely of a relatively soluble substance. There was little evidence of ponding or other water accumulations over the salt cake and runoff from the area seems to have been effectively controlled, therefore rainfall must be seeping or percolating through the salt cake and into the soil-bedrock substrate.

In summary, this site should not be further considered for waste disposal purposes, nor should soluble (leachable) chemical type substances be stored here in the open without weather protection.

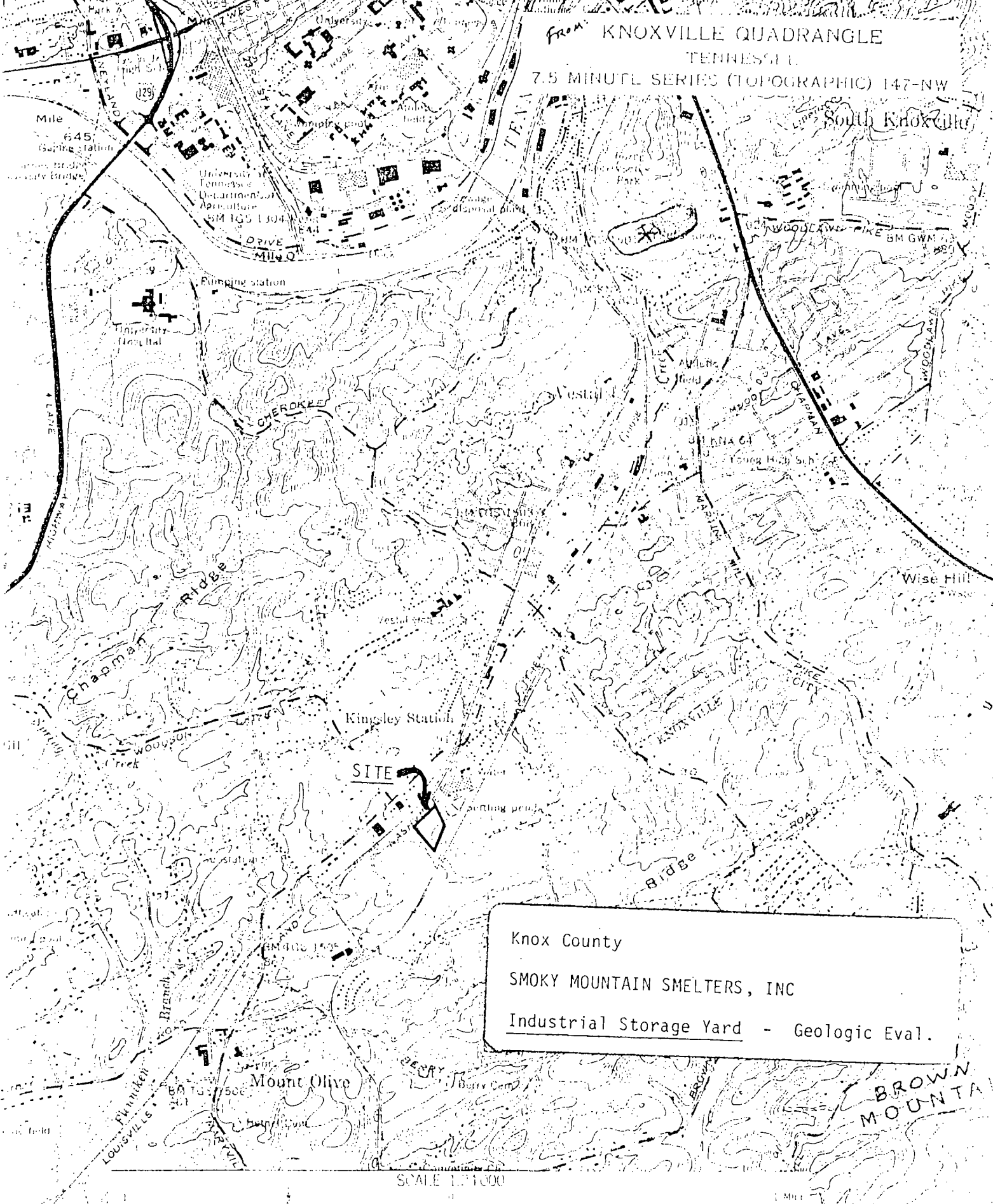


Glenn N. Pruitt
Geologist
Division of Solid Waste Management

GNP/ekj
cc: J. Crabtree
DSWM - Nashville

FROM KNOXVILLE QUADRANGLE
TENNESSEE
7.5 MINUTE SERIES (TOPOGRAPHIC) 147-NW

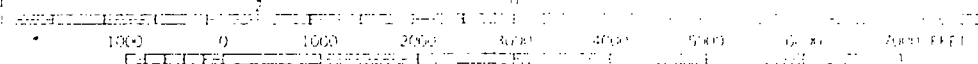
South Knoxville



Knox County
SMOKY MOUNTAIN SMELTERS, INC
Industrial Storage Yard - Geologic Eval.

BROWN MOUNTAIN

SCALE 1:1000



CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

GEOLOGY OF THE
KNOXVILLE QUADRANGLE
TENNESSEE

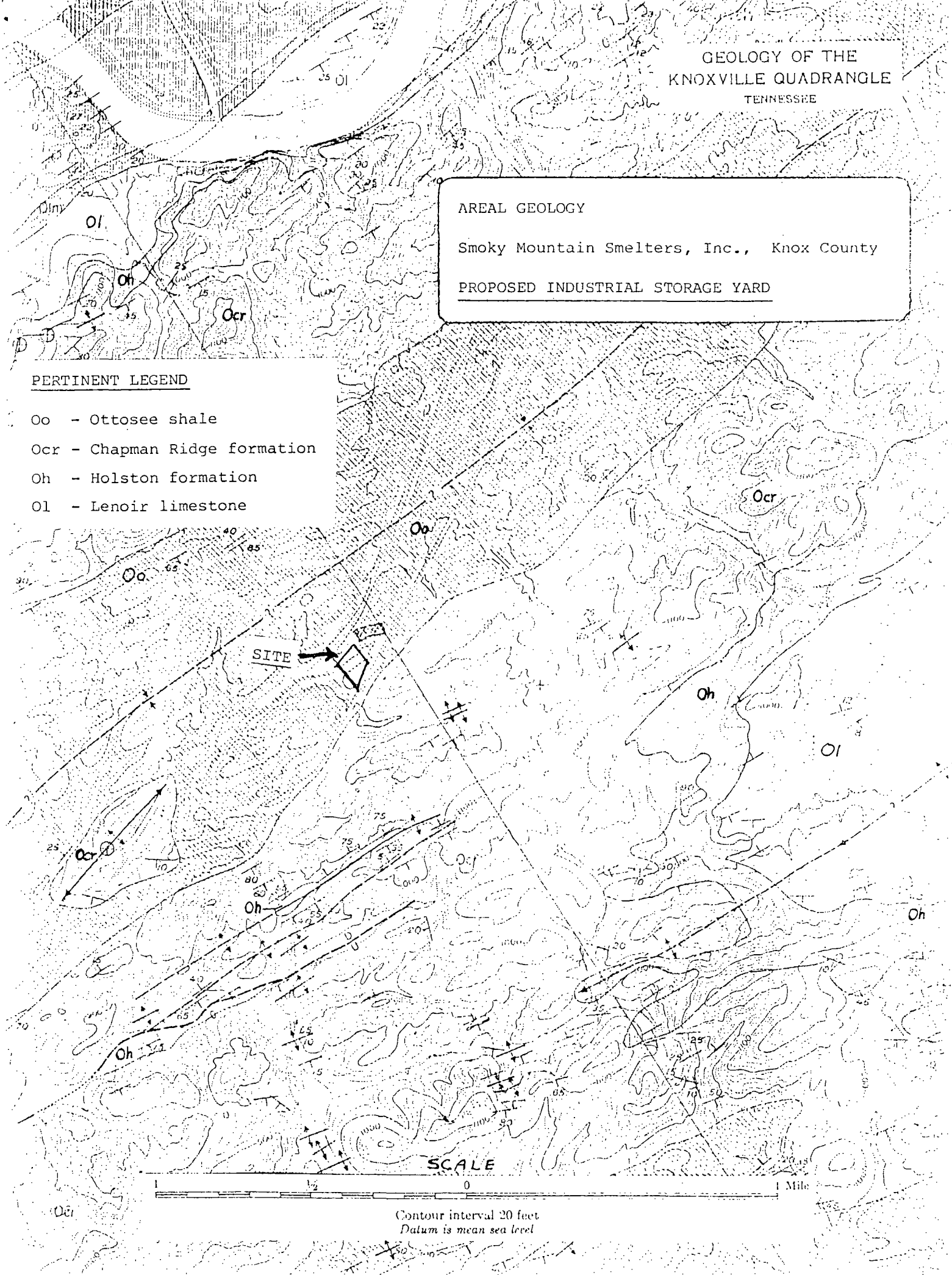
AREAL GEOLOGY

Smoky Mountain Smelters, Inc., Knox County

PROPOSED INDUSTRIAL STORAGE YARD

PERTINENT LEGEND

- Oo - Ottosee shale
- Ocr - Chapman Ridge formation
- Oh - Holston formation
- Ol - Lenoir limestone



" Special Solid Waste Notice of Approval "

TDHE/Division of Solid Waste Management (DSWM). 1990. Tennessee Department of Health and Environment, Special Solid Waste Notice of Approval (Letter #2468/2640), issued to Smokey Mountain Smelters, Inc. October 12.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

file?
Special waste
Knox Co. 1990
~~1990~~



File Copy

STATE OF TENNESSEE
DEPARTMENT OF HEALTH AND ENVIRONMENT
2700 Middlebrook Pike
Suite 220

October 12, 1990

Knoxville, Tennessee 37921

NOTICE OF APPROVAL
SPECIAL SOLID WASTE
SNL 47-103-0177 or
01-103-0160
Letter # 2468/2640

Mr. Daniel E. Johnson, President
Smokey Mountain Smelters, Inc.
P. O. Box 2704
Knoxville, Tennessee 37901

RE: Disposal of Waste Salt Cake from Aluminum Dross Re-Smelting

Dear Mr. Johnson:

The Division of Solid Waste Management has reviewed the special solid waste information you submitted to our office in accordance with the Regulations Governing Solid Waste Processing and Disposal in Tennessee.

After reviewing the physical and chemical properties from the special waste information, the Department has determined the waste suitable for disposal in the BFI Twin Oaks or Waste Management Chestnut Ridge Sanitary Landfill. However, should the chemical or physical properties of the waste change significantly (i.e., quantity, moisture content, pH, etc.), the waste must be reevaluated by the Department. The estimated quantity of waste is 3-4 30 cubic yard truckloads per week.

In order for this waste to be properly and safely disposed of in a sanitary landfill, the following procedures must be followed:

1. Since we have received no response from you since January of this year concerning selling this material as a marketable commodity or permitting your own landfill, we must assume that this material has been and is being disposed of on your property without a permit. We are therefore instructing you to begin removing the waste and hauling it to one of the landfills as soon as arrangements can be completed.
2. Any newly generated salt cake waste must be allowed to cool thoroughly before delivering it to the landfill.

Mr. Daniel E. Johnson, President
Smokey Mountain Smelters, Inc.

Page 2

October 12, 1990

3. Newly generated salt cake waste must be protected from rain and kept dry until it is delivered to the landfill. All trucks hauling salt cake waste to the landfill must be covered.
4. Deliveries of this waste must not be made when it is raining or if the ground is wet.
5. The waste must be covered with soil as soon as possible after it is delivered to the landfill. It must be placed in a separate cell from municipal garbage although it may be co-disposed with fly ash or other similar dry special wastes. Cover must be applied before rain begins or before the end of the working day, whichever comes first.
6. An exception may be made for old wastes for which the reaction with moisture is essentially complete. Waste may be removed from the back of the pile, where it is estimated to be about ten years old, and managed by co-disposing it with any solid waste that is not wet (although preferably with drier wastes such as construction debris) so long as weather conditions are favorable and the waste is completely covered with soil by the end of the day.

Representative samples should be taken of the waste from the back of the pile toward the front and reacted with water under controlled conditions in a laboratory, to determine which wastes will react with water to form ammonia and whichones will not. Based on this testing a site drawing should be submitted to the Division defining what areas of the pile should be treated as old, non-reactive wastes and which should be treated as new (reactive) waste. Without such data only those wastes along the back of the pile, which were placed first, may be treated as "old" wastes.

If at any time an ammonia odor is detected when a truckload of this waste is uncovered, it must be managed in accordance with condition #5.

Mr. Daniel E. Johnson, President
Smokey Mountain Smelters, Inc.

Page 2

October 12, 1990

If you have any questions or require additional assistance,
please contact this office.

Sincerely,

Rick Brown

Rick Brown
Environmental Engineer

RSB:29169258

SW17

cc: Division of Solid Waste Management-Central Office
BFI Twin Oaks Registered Sanitary Landfill
Waste Management Chestnut Ridge Registered Sanitary
Landfill

" Reservoir and Stream Quality "

TVA. 1993. "Tennessee Valley Reservoir and Stream Quality - 1993". Tennessee Valley Authority, Division of Water Management, May 1994.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

JEB ✓ 8-22

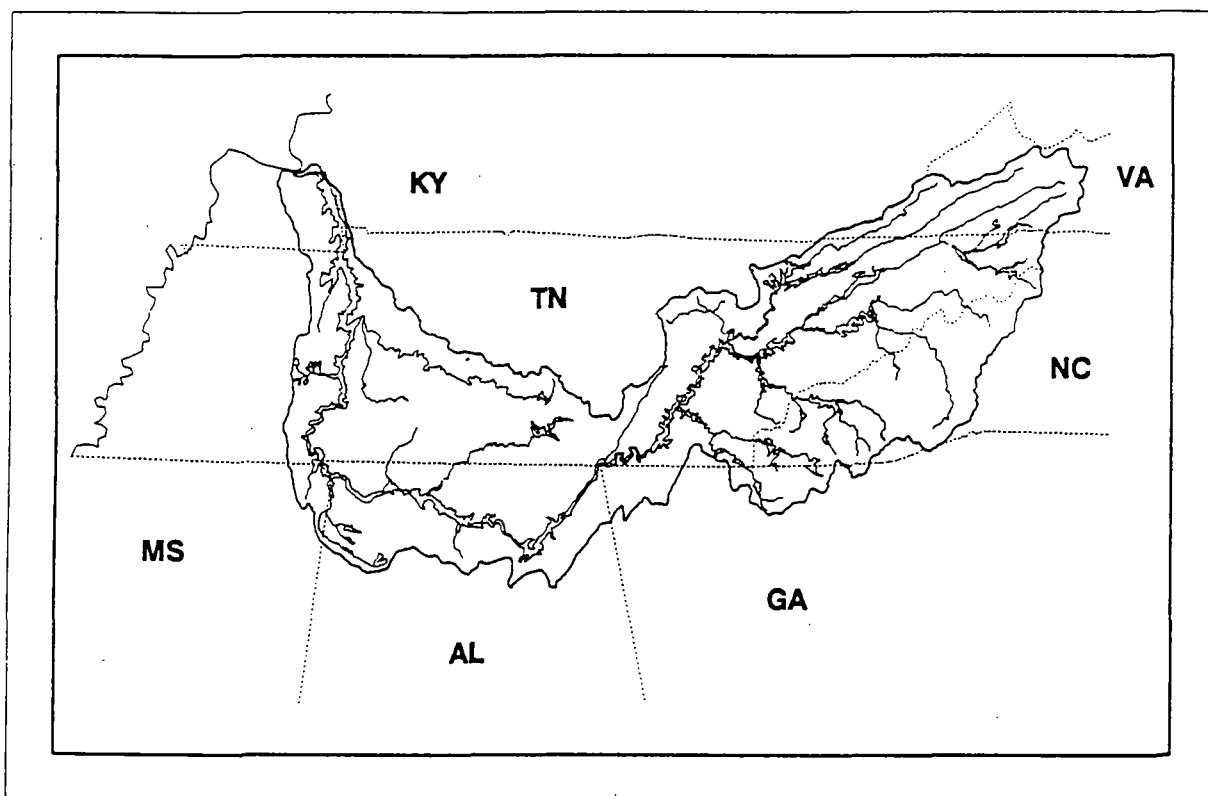
Tennessee Valley Authority

Water Management
Chattanooga, Tennessee

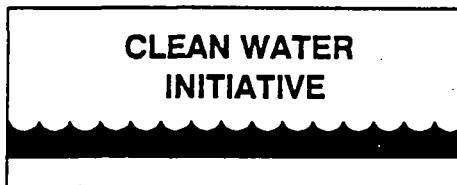
May 1994

TENNESSEE VALLEY RESERVOIR AND STREAM QUALITY - 1993 SUMMARY OF VITAL SIGNS AND USE SUITABILITY MONITORING

VOLUME I



CLEAN WATER
INITIATIVE



13.2 Fort Loudoun Reservoir

Physical Description

Fort Loudoun Reservoir is the ninth and uppermost reservoir on the Tennessee River with the dam located at TRM 602.3. The surface area and shoreline are relatively small (14,600 acres and 360 miles, respectively) considering the length (61 miles), indicating it is mostly a run-of-the-river reservoir. The average annual discharge from Fort Loudoun Dam is 18,400 cfs which provides an average hydraulic retention time of about ten days.

Fort Loudoun Reservoir (and the Tennessee River) is formed by the confluence of the French Broad and Holston Rivers, with both of these rivers having a major reservoir upstream. Douglas Dam, 32.3 miles up the French Broad River, and Cherokee Dam, 52.3 miles up the Holston River, form deep storage impoundments, each having long retention times. Both of these deep storage impoundments become strongly stratified during summer months resulting in the release of cool, low DO, hypolimnetic water during operation of the hydroelectric units. Some warming and reaeration of the water occurs downstream from Cherokee and Douglas Dams, but both temperature and DO levels are sometimes low when the water reaches Fort Loudoun Reservoir.

Fort Loudoun Reservoir also receives surface waters from the Little Tennessee River, via the Tellico Reservoir canal, which connects the forebays of the two reservoirs. (Since Tellico Dam has no outlet, under most normal conditions, water flows into Fort Loudoun Reservoir from Tellico Reservoir.) Water from Tellico Reservoir (Little Tennessee River) is often cooler and higher in DO, and has a much lower conductivity than water in Fort Loudoun Reservoir (Tennessee River). In 1992, the forebay sampling location on Fort Loudoun Reservoir (originally located at TRM 603.2) was moved upstream to TRM 605.5. This resulted in a better assessment of the water quality conditions of the Tennessee River in the forebay portion of Fort Loudoun Reservoir by minimizing the effects of the Little Tennessee River and Tellico Reservoir on the data gathered in the forebay of Fort Loudoun Reservoir.

Although Fort Loudoun Reservoir is a mainstream reservoir, its complex set of hydrologic conditions (cool water inflows from the Holston, French Broad, and Little Tennessee Rivers) often causes it to exhibit several characteristics that are more typical of a storage impoundment. In fact, analysis of historical fisheries data for the Tennessee Valley indicates the fish community of Fort Loudoun Reservoir is more similar to that in Valley storage impoundments than in other mainstream reservoirs.

Ecological Health

Vital Signs monitoring information showed the ecological health of Fort Loudoun Reservoir was between fair and poor in 1993 (58 percent), basically similar to 1992 (53 percent) and 1991 (60 percent). The only ecological health indicator which rated good or excellent on Fort Loudoun was DO at the forebay and transitions zone (no data were available from the inflow). Such good ratings for DO were surprising based on observations of lower DOs in 1993 in other mainstream reservoirs and historical concerns about DO in Fort Loudoun Reservoir.

Several indicators rated poor or very poor. Sediment quality at the forebay rated poor due to high zinc concentrations, presence of chlordane, and toxicity to Ceriodaphnia. Transition zone sediments rated fair with similar conditions as the forebay, but no toxicity to test organisms was found. These findings are consistent with results found in previous years. The fish assemblage rated poor at all three sample sites (forebay, transition zone, and inflow) mostly due to low species richness and low capture rate of individuals (similar to previous years). Benthic macroinvertebrates rated very poor at the inflow site due to low species richness and abundance (comparable to previous years). Benthos rated fair at the forebay and transition zone. Similar results had been found at the transition zone in previous years, but benthic invertebrates at the forebay improved in several metrics, especially species richness and reduced dominance by tolerant organisms.

Aquatic macrophytes only covered 25 acres on Fort Loudoun Reservoir in 1993. Coverage over the past decade has ranged 25 to 140 acres.

Reservoir Use Suitability

TDEC has issued advisories on consumption of two fish species from Fort Loudoun Reservoir. Tennessee advises people not to eat catfish taken from Fort Loudoun Reservoir because of high levels of PCBs. Also, largemouth bass should not be eaten if they weigh over two pounds or are caught in the Little River embayment due to PCB contamination.

Fort Loudoun Reservoir has had a PCB problem for more than 20 years. Initially, TVA and state agencies examined a variety of species from throughout the reservoir to document the geographical and species variation. The study now continues as a trend study in which there is an annual collection of catfish from one location. PCB concentrations in catfish have varied over the years with no distinct trend.

Fecal coliform concentrations at one boat ramp tested in 1993 were within criteria for recreation. In 1989, 1990, and 1992, fecal coliform samples were collected at a total of three

" Fort Loudoun Reservoir Annual Report "

TWRA. 1993. "Fort Loudoun Reservoir Annual Report". Tennessee Wildlife Resources Agency, region IV. Prepared by D. Peterson and J. Negus.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

JUL 19 1994

**FORT LOUDOUN RESERVOIR
ANNUAL REPORT
1993**

**PREPARED BY:
DOUGLAS C. PETERSON AND JAMES A. NEGUS**

**THIS REPORT COVERS ALL OR PORTIONS OF PROJECT(S):
4311, 4312**

FORT LOUDOUN RESERVOIR

ANNUAL REPORT

1993

Prepared by:

Douglas C. Peterson
and
James A. Negus

Tennessee Wildlife Resources Agency
Region IV
6032 West Andrew Johnson Highway
Talbott, Tennessee 37877

Development of this report financed in part by funds
from Federal Aid in Fish and Wildlife Restoration
(Public Law 91-503) as documented in
Federal Aid Project FW-6 (4311 and 4312)

This program receives Federal Aid in Fish and Wildlife Restoration. Under Title VI of the Civil Rights Act of 1964 and Section 504 of the Rehabilitation Act of 1973, the U.S. Department of the Interior prohibits discrimination on the basis of race, color, national origin, or disability. If you believe you have been discriminated against in any program, activity, or facility as described above, or if you desire further information, please write to: Office of Equal Opportunity, U.S. Department of the Interior, Washington, D.C. 20240

DESCRIPTION OF THE STUDY AREA

Fort Loudoun Reservoir, a Tennessee Valley Authority (TVA) impoundment, was created in 1943 (Figure 1). The reservoir contains 14,600 surface acres and provides hydroelectric power, flood control, and a navigational route (TVA 1985).

The impoundment is located at the headwaters of the Tennessee River near Knoxville. It extends 55 miles upstream from Fort Loudoun Dam (TRM 602.4) to the confluence of the Holston and French Broad Rivers (TRM 657.4). Since the reservoir is a navigable mainstream waterway, the annual drawdown is only six vertical feet and water levels fluctuate between 813 and 807 feet above mean sea level (MSL).

Fort Loudoun Reservoir is surrounded by private and commercial development and is used extensively for fishing and other aquatic recreations. The most commonly harvested fish species are largemouth, smallmouth, and white bass, along with bluegill and white and black crappie.

Forage

The number of forage fish per acre increased greatly in 1993 when compared to the average of previous samples (Table 54). The weight of forage fish per acre also increased when compared to the 1988 sample, however, decreased in comparison to the 1961-1984 efforts. The increased

number of forage species was primarily a result of the prolific threadfin shad. There were nearly 20,000 YOY threadfin

Year	# forage/acre	lb/acre
1961-1984	7,706.7	189.4
1988	7,848.4	93.5
1993	11,494.0	113.3

collected from the two sites in 1993 (Table 51). The decrease in biomass of forage species when compared to the historical average can be attributed to the decreased number and weight of gizzard shad collected.

CREEL

It was estimated that anglers spent 147,063 hr fishing in the reservoir during 1993 (Table 57). This exploitation rate is considerably lower than the rate determined in 1986 (233,900 hr) and the average rate of the 1980-1986 creel surveys (504,572 hr) (Figure 19) (TWRA and TTU 1991).

Fifty-six percent of the angling effort was concentrated at catching black bass (LMB and SMB) while 16% and 12% was geared toward catching "any species" and crappie, respectively (Table 63). Although sunfish were not subjected to the greatest amount of

angling pressure, they were the most caught and harvested of all species (Table 58). White bass and white crappie were the second and third most harvested fish.

There were a greater number of LMB, SMB, WC, BC, and BG harvested during the early 1980s than during any other period between 1979 and 1993 (Figures 20-21). Harvest rates were also determined to be the greatest at that time for LMB, BC, and BG (Figure 23). The gradual decrease in angling pressure since the early 1980s has apparently resulted in the decrease in the number of fish harvested and in the harvest rates of many game species (Figure 19).

AGE AND GROWTH

Scales removed from 87 LMB, 34 SMB, 51 BC, and 18 WC were analyzed to determine mean length at age (Tables 69-78). Growth rates for these species were comparable at nearly all ages to the results from previous sampling efforts (Figures 24-27). Therefore, these data implies the rate at which LMB, SMB, BC, and WC are growing in the reservoir is normal.

ANNUAL SUMMARY OF CREEL DATA FOR ALL ANGLERS BY RESERVOIR-1993

RESERVOIR=PORT LOUDON

COMMON NAME	ESTIMATED NUMBER CAUGHT	ESTIMATED NUMBER HARVESTED	CATCH INDEX	HARVEST INDEX	AVERAGE WEIGHT	PERCENT HARVESTED	NUMBER CREELED
CARP	1039.72	0.00	0.01	0.00	.	0.00	0
FLATHEAD CATFISH	159.96	119.97	0.00	0.00	3.95	75.00	3
BLUE CATFISH	2119.44	959.74	0.01	0.01	3.01	45.28	24
CHANNEL CATFISH	1559.59	519.86	0.01	0.00	1.86	33.33	13
BULLHEAD	39.99	0.00	0.00	0.00	.	0.00	0
YELLOW BULLHEAD	199.95	199.95	0.00	0.00	1.69	100.00	5
FRESHWATER DRUM	839.78	79.98	0.01	0.00	1.89	9.52	2
STRIPED BASS	39.99	0.00	0.00	0.00	.	0.00	0
WHITE BASS	6358.31	4318.85	0.04	0.03	0.58	67.92	108
YELLOW BASS	359.90	159.96	0.00	0.00	0.24	44.44	4
WALLEYE	39.99	39.99	0.00	0.00	1.90	100.00	1
SAUGER	39.99	39.99	0.00	0.00	1.00	100.00	1
YELLOW PERCH	39.99	0.00	0.00	0.00	.	0.00	0
LARGEMOUTH BASS	16235.68	2879.23	0.11	0.02	1.87	17.73	72
SMALLMOUTH BASS	4078.92	999.73	0.03	0.01	2.70	24.51	25
WHITE CRAPPIE	5598.51	3519.06	0.04	0.02	0.69	62.86	88
BLACK CRAPPIE	359.90	359.90	0.00	0.00	0.56	100.00	9
BLUEGILL	23953.63	7957.88	0.16	0.05	0.18	33.22	199

ESTIMATED WEIGHT OF FISH HARVESTED FROM FORT LONDON RESERVOIR

<u>No. Harvested</u>	<u>Avg. wt</u>	<u>TOTAL POUNDS</u>	<u>SPECIES</u>
119.97	x 3.95 =	473.83	Flathead Catfish
959.74	x 3.01 =	2888.82	Blue Catfish
519.86	x 1.86 =	966.94	Channel Catfish
199.95	x 1.69 =	337.92	Yellow Bullhead
79.98	x 1.89 =	151.16	DRUM
4318.85	x 0.58 =	2504.93	White Bass
159.96	x 0.24 =	38.39	Yellow Bass
39.99	x 1.90 =	75.98	Walleye
39.99	x 1.00 =	39.99	Sauger
2879.23	x 1.87 =	5384.16	Largemouth Bass
999.73	x 2.70 =	2699.27	Smallmouth Bass
3519.06	x 0.69 =	2428.15	White Crappie
359.90	x 0.56 =	201.54	Black Crappie
7957.88	x 0.18 =	1432.42	Bluegill
Estimated Total		<u>19,623.55</u>	pounds Harvested in 1913.

" Water Wells on the Maryville Quadrangle "

TDEC/DWS. 1997b. Records of Water Wells on the Maryville Quadrangle
(0147SW) TN. November 12. Pp.:35-43.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
 RECORDS OF WATER WELLS ON THE *mapville* QUADRANGLE (0147SW) TN.

QUAD / COUNTY	NTH REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER USE
0147SW KNOX	3 09301669	KNIGHT STEV MARTIN MILL PIK	05/02/1983 07/28/1983	231 150	-- 60	142 STEEL	OPEN 142 - 231	GOOD	35-51-25 83-52-49	S Y	00385 HOME
0147SW BLOUNT	1 00900137	JONES E	12/08/1965 / /	147 125	15 90	95 STEEL	-- - --		35-51-34 83-59-25	S	00138 HOME
0147SW BLOUNT	1 00900201	WITHERSPOON D	02/06/1967 / /	354 311	150 75	52 STEEL	-- - --	GOOD	35-51-10 83-59-03	S	00385 IND
0147SW BLOUNT	1 00900232	REPAP E	12/29/1967 / /	78 --	-- 10	24 STEEL	-- - --		35-52-15 83-59-50	S	00093 HOME
0147SW BLOUNT	1 00901180	(b) (6) RIVER RD	(b) (6) 09/14/1982 / /	250 125	5 65	42 STEEL	OPEN 42 - 250	GOOD	- - - -	- Y	00383 HOME
0147SW BLOUNT	1 00901426	ANDERSON MICK BEAU'S BEND	03/24/1986 / /	165 102	12 100	40 STEEL	OPEN -- - --	GOOD	- - - -	- Y	00622 HOME
0147SW BLOUNT	1 00901458	BURY FRED FOX HILLS	07/09/1986 / /	450 407	5 84	145 STEEL	OPEN 145 - 450	GOOD	- - - -	- Y	00622 HOME
0147SW BLOUNT	1 00901536	(b) (6) FOX HILL RD	(b) (6) 06/08/1987 / /	100 95	35 30	41 STEEL	OPEN 41 - 100	GOOD	- - - -	- Y	00622 HOME
0147SW KNOX	1 09301230	CURTIS BILL LITTLE RIVER	06/20/1978 / /	395 370	13 --	135 STEEL	-- - --	GOOD	35-52-10 83-58-15	S	00385 HOME
0147SW KNOX	1 09301239	PATTERSON JACK TOPSIDE	05/00/1978 / /	460 --	8 --	154 STEEL	-- - --	GOOD	35-52-21 83-57-56	S	00138 HOME
0147SW KNOX	1 09301549	WITHEPSPOON D.	11/13/1981 / /	128 113	104 15	63 STEEL	-- - --	GOOD	35-52-27 83-58-45	S	00385
0147SW KNOX	1 09301585	P.B.S.CONST. COMPAN	06/08/1982 / /	300 260	9 80	74	-- - --	GOOD	35-51-57 83-58-20	S	00138 HOME
0147SW KNOX	1 09301596	STRICKLAND MR.	01/20/1982 / /	395 385	30 65	122 STEEL	-- - --	GOOD	35-52-05 83-58-25	S	00385 HOME
0147SW BLOUNT	1 92002077	DUNLAP MICH BEAUS BEND	05/22/1992 / /	300 89	4 49	62 STEEL	OPEN 62 - 300	GOOD	- - - -	- Y	00622 HOME
0147SW BLOUNT	1 92002660	WOLFE BUDD BEND ROAD	07/09/1992 / /	200 105	10 73	104 STEEL	OPEN 104 - 200	GOOD	- - - -	- Y	00622 HOME
0147SW BLOUNT	1 94003421 D0005184	(b) (6) FOX HILLS DRIVE	(b) (6) 09/07/1994 / /	175 102	29 27	62 STEEL	OPEN 62 - 175	GOOD	- - - -	- Y	00622 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE (0147SW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER USE
0147SW 1 KNOX	94004049 D0000000	PUCKETT _____ DON_	09/25/1994 / /	441 405	20 80	85 STEEL	OPEN 85 - 441	GOOD	- - - -	- Y	00385 HOME
0147SW 1 BLOUNT	95004598 D0011971	HUMPHREYS _____ LAUR	09/28/1995 / /	250 155	21 48	77 STEEL	OPEN 77 - 250	GOOD	- - - -	- Y	00622 HOME
0147SW 1 BLOUNT	96000821 D0010098	WATERS _____ GREG	02/22/1996 / /	75 66	100 26	38 STEEL	OPEN 38 - 75	GOOD	- - - -	- Y	00622 HOME
0147SW 1 BLOUNT	96004512 D0022205	HOFFMEISTER _____ AL_	09/26/1996 / /	162 85	30 --	76 STEEL	OPEN 76 - 162	OTHR	- - - -	- Y	00385 HOME
0147SW 2 BLOUNT	00900233	CARR J	12/15/1967 / /	100 --	-- 20	60 STEEL	-- - --		35-51-45 83-57-20	S -	00093 HOME
0147SW 2 BLOUNT	00900234	CUTINGHAM E	11/30/1967 / /	100 --	-- 24	30 STEEL	-- - --		35-51-27 83-57-02	S -	00093 HOME
0147SW 2 BLOUNT	00900235	DEAL J	11/20/1967 / /	130 --	-- 40	40 STEEL	-- - --		35-51-05 83-56-55	S -	00093 HOME
0147SW 2 BLOUNT	00900281	ROSS FRAN	11/04/1965 01/15/1985	300 285	40 60	40 STEEL	-- - --	GOOD	35-51-15 83-55-35	S -	00080 HOME
0147SW 2 BLOUNT	00901112	(b) (6) _____ (b) (6) RODDY BRANCH	05/09/1983 07/28/1983	65 36	-- 2	13 STEEL	OPEN 13 - 65	OTHR	35-51-17 83-55-52	S Y	00385 HOME
0147SW 2 BLOUNT	00901170	(b) (6) _____ (b) (6) RODDY BRANCH RD	08/09/1984 / /	180 93	6 10	82 STEEL	OPEN 82 - 180	BAD	- - - -	- Y	00385 HOME
0147SW 2 KNOX	09302156	BLAZIER _____ DAVI	11/17/1989 / /	570 565	80 100	272 STEEL	OPEN 272 - 570	OTHR	- - - -	- Y	00264 HOME
0147SW 2 KNOX	92002454	PATTERSON _____ ANNA	04/15/1992 / /	390 380	30 110	199 STEEL	OPEN 199 - 390	GOOD	- - - -	- Y	00536 HOME
0147SW 2 BLOUNT	92003857	(b) (6) _____ (b) (6) HWY 33	08/01/1992 / /	405 385	15 150	343 STEEL	OPEN 343 - 405	OTHR	- - - -	- Y	00608 HOME
0147SW 2 KNOX	93004729	(b) (6) _____ (b) (6) TIPTON STA RD	05/27/1992 / /	242 57	8 25	38 STEEL	OPEN 38 - 242	OTHR	- - - -	- Y	00385 HOME
0147SW 2 KNOX	93004743	(b) (6) G _____ (b) (6) 2206 LITTLE VAL	10/22/1993 / /	182 126	12 20	87 STEEL	OPEN 87 - 182	OTHR	- - - -	- Y	00385 HOME
0147SW 2 KNOX	93004744	(b) (6) _____ (b) (6) TOP SIDE RD	09/18/1993 / /	381 305	25 80	152 STEEL	OPEN 152 - 381	H2S	- - - -	- Y	00385 IRR

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADANGLE (0147SW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER
0147SW 2 KNOX	94004035 D0002899	(b) (6) _____ (b) (6) I TARKIN VALLEY R	04/14/1994 / /	260 102	30 35	87 STEEL	OPEN 87 - 260	UNK	- - - -	Y	00385 HOME
0147SW 2 KNOX	94004036 D0002900	(b) (6) _____ (b) (6) TARKIN VALLEY R	04/15/1994 / /	100 55	.60 20	21 STEEL	OPEN 21 - 100	OTHR	- - - -	Y	00385 HOME
0147SW 2 BLOUNT	95004561 D0007908	EDINGTON _____ MARK RODDY BRANCH	09/25/1995 / /	140 128	50 --	39 STEEL	OPEN 39 - 140	OTHR	- - - -	Y	00385 HOME
0147SW 3 BLOUNT	00901097	LYON B.L.	05/18/1982 / /	108 107	17 12	42 STEEL	-- --	GOOD	35-50-14 83-52-40	S	00385 HOME
0147SW 3 BLOUNT	00901153	LYONS _____ B.L GLOVER	09/10/1983 12/19/1983	250 140	52 25	109 STEEL	OPEN 109 - 250	GOOD	35-50-14 83-52-36	S Y	00385 HOME
0147SW 3 BLOUNT	00901641	(b) (6) _____ (b) (6) SELF HOLLOW RD	08/07/1988 / /	275 255	12 75	67 STEEL	OPEN 67 - 275	OTHR	- - - -	Y	00383 HOME
0147SW 3 BLOUNT	00901717	(b) (6) _____ (b) (6) RODDY BRANCH RD	02/10/1989 / /	145 130	30 1	41 STEEL	OPEN 41 - 145	OTHR	- - - -	Y	00608 HOME
0147SW 3 BLOUNT	00901773	REIHL _____ ALAN KERR	07/20/1989 / /	210 180	10 45	119 STEEL	OPEN 119 - 210	OTHR	- - - -	Y	00383 HOME
0147SW 3 KNOX	09300031	COSTNES F BLAZER	11/16/1963 / /	74 --	-- --	58 STEEL	-- --	GOOD	35-51-22 83-53-21	S	00241 HOME
0147SW 3 KNOX	09301371	BROGDEN J	06/15/1979 / /	374 370	4 65	21 STEEL	-- --	GOOD	35-51-54 83-54-30	S	00385 HOME
0147SW 3 KNOX	09301529	EDWARDS J.	10/08/1981 / /	-- --	8 --	63 STEEL	-- --	GOOD	35-50-50 83-53-26	S	00138 HOME
0147SW 3 KNOX	09301550	FLOYD MR.	09/29/1981 / /	190 180	13 40	42	-- --	GOOD	35-51-55 83-53-29	S	00385 HOME
0147SW 3 KNOX	09301554	MORELAND R.	06/23/1981 / /	228 205	25 60	42 STEEL	-- --	GOOD	35-52-04 83-53-25	S	00385 HOME
0147SW 3 KNOX	09301577	BOBB TONY	02/23/1982 / /	310 287	6 95	63 STEEL	-- --	GOOD	35-52-27 83-52-35	S	00580 HOME
0147SW 3 KNOX	09301668	KNIGHT _____ BILL LOUIS WISE	05/04/1983 07/28/1983	185 108	-- 500	81 STEEL	OPEN 81 - 185	GOOD	35-51-49 83-52-34	S Y	00385 HOME
0147SW 3 KNOX	09301706	(b) (6) _____ (b) (6) MARTIN MILL PK	08/10/1983 08/11/1983	125 117	50 40	93 STEEL	OPEN 93 - 125	GOOD	35-51-34 83-53-03	S N	00385 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADRANGLE (0147SW) TN.

QUAD / COUNTY	NTH REG NUM	WELL NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147SW 3 KNOX	09301769	(b) (6)	(b) (6) _____ MARTIN MILL PIK	06/28/1984 / /	300 290	30 100	105 STEEL	OPEN 105 - 300	GOOD	- - - -	- Y	00383 HOME
0147SW 3 KNOX	09301770	(b) (6)	(b) (6) _____ MARTIN MILL PIK	06/21/1984 / /	250 240	8 85	85 STEEL	OPEN 85 - 250	GOOD	- - - -	- Y	00383 HOME
0147SW 3 KNOX	09301861	(b) (6)	(b) (6) _____ MCCAMMA RD	02/16/1985 / /	290 250	10 80	43 STEEL	OPEN 43 - 290	OTHR	- - - -	- Y	00536 HOME
0147SW 3 KNOX	09301938	ROOD _____ MARTIN MILL	JODY / /	08/27/1986 / /	200 180	10 --	54 STEEL	OPEN 54 - 200	OTHR	- - - -	- Y	00138 HOME
0147SW 3 KNOX	09301970	LORD _____ MCCAMMON	JIM / /	05/15/1985 / /	250 220	8 50	62 STEEL	OPEN 62 - 250	OTHR	- - - -	- Y	00536 HOME
0147SW 3 KNOX	09301976	ABERCROMBIE _____ MARTIN MILL PIK	DAVI / /	10/30/1986 / /	200 175	60 60	83 STEEL	OPEN 83 - 200	OTHR	- - - -	- Y	00383 HOME
0147SW 3 KNOX	09301977	HAFFMASTER _____ MCCANMAN	H_L / /	10/29/1986 / /	275 250	25 50	189 STEEL	OPEN 189 - 275	OTHR	- - - -	- Y	00383 HOME
0147SW 3 KNOX	09301979	(b) (6) _____ LYNNWOOD DR	(b) (6) / /	05/16/1987 / /	225 105	30 60	115 STEEL	OPEN 115 - 225	OTHR	- - - -	- Y	00383 HOME
0147SW 3 KNOX	09309175	G. R. STUBBS		10/00/1979 / /	180 --	-- --	-- STEEL	-- - --	BAD	35-51-52 83-54-31	S	00412 HOME
0147SW 3 BLOUNT	90000496	LYNN _____ MR	MR / /	08/25/1989 / /	327 321	70 --	294 STEEL	OPEN 294 - 327	OTHR	- - - -	- Y	00385 HOME
0147SW 3 KNOX	90000728	(b) (6) _____ 8831 MARTIN MIL	(b) (6) / /	02/27/1990 / /	362 352	20 4	121 STEEL	OPEN 121 - 362	OTHR	- - - -	- Y	00385 HOME
0147SW 3 BLOUNT	91001150	(b) (6) _____ BLAZIER RD	(b) (6) / /	02/22/1991 / /	225 200	15 110	105 STEEL	OPEN -- - --	OTHR	- - - -	- Y	00152 HOME
0147SW 3 BLOUNT	91003389	SHENLEW _____ MIKE	MIKE / /	07/04/1991 / /	890 830	1 60	102 STEEL	OPEN 102 - 890	UNK	- - - -	- Y	00264 HOME
0147SW 3 KNOX	92000868	(b) (6) _____ MCCAMMON RD	(b) (6) / /	10/24/1991 / /	401 232	7 --	134 STEEL	OPEN 134 - 401	UNK	- - - -	- Y	00385 HOME
0147SW 3 KNOX	93004365	(b) (6) _____ MCCAMMON2547	(b) (6) 4/20/1994	09/30/1993 4/20/1994	465 260	10 50	104 STEEL	OPEN 104 - 465	UNK 008295	35-51-23 83-53-19	S Y	00536 HOME
0147SW 3 KNOX	94000005 D0005107	(b) (6) _____ MCCAMMON DRIVE	(b) (6) / /	12/01/1993 / /	425 135	6 56	102 PLAST	OPEN 102 - 425	GOOD	- - - -	- Y	00622 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADRANGLE (0147SW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER
0147SW 3 KNOX	94001662 D0002193	BALLOW _____TAE	05/25/1994 / /	465 300	20 100	116 STEEL	OPEN 116 - 465	GOOD	- - - -	Y	00264 HOME
0147SW 3 BLOUNT	94003517 D0008573	(b) (6) f _____(b) (6) JAY KERR RD 3856	08/22/1994 6/ 6/1995	245 200	10 30	75 STEEL	OPEN 75 - 245	UNK 008838	35-50-15 83-53-08	S Y	00684 HOME
0147SW 3 KNOX	94004232 D0009412	(b) (6) _____(b) (6) 2700 BLAZIER RD	10/17/1994 6/20/1995	530 200	3 40	62 STEEL	OPEN 62 - 530	UNK 008871	35-50-49 83-53-24	S Y	00264 HOME
0147SW 3 BLOUNT	95002775 D0007882	(b) (6) _____(b) (6) GLOVER ROAD	06/06/1995 / /	581 330	7 --	47 STEEL	OPEN 47 - 581	OTHR	- - - -	Y	00385 HOME
0147SW 3 KNOX	95004018 D0007900	(b) (6) _____(b) (6) MCCANNON	08/23/1995 / /	220 --	60 --	104 STEEL	OPEN 104 - 220	OTHR	- - - -	Y	00385 HOME
0147SW 3 BLOUNT	95004391 D0014252	(b) (6) _____(b) (6) Y KERR	08/15/1995 / /	200 195	60 30	63 STEEL	OPEN 63 - 200	OTHR	- - - -	Y	00383 HOME
0147SW 3 KNOX	96002624 D0016890	(b) (6) S _____(b) (6) MCCANNON RD	05/21/1996 / /	240 155	60 60	120 STEEL	OPEN 120 - 240	OTHR	- - - -	Y	00385 HOME
0147SW 3 BLOUNT	96003055 D0020967	(b) (6) _____(b) (6) KERR RD	07/02/1996 / /	225 190	15 60	133 STEEL	OPEN 133 - 225	OTHR	- - - -	Y	00608 HOME
0147SW 3 KNOX	96003656 D0020179	(b) (6) _____(b) (6) MCCAMMON ROAD	07/24/1996 / /	222 102	30 --	80 STEEL	OPEN 80 - 222	OTHR	- - - -	Y	00385 HOME
0147SW 3 KNOX	97000067 D0022563	(b) (6) _____(b) (6) MCCAMMON RD	10/22/1996 / /	345 325	25 90	186 STEEL	OPEN 186 - 345	UNK	- - - -	Y	00536 HOME
0147SW 3 KNOX	97003339 D0022188	(b) (6) _____(b) (6) MCCAMMON RD	07/21/1997 / /	120 100	15 --	84 STEEL	OPEN 84 - 120	OTHR	- - - -	Y	00385 HOME
0147SW 4 BLOUNT	00901778 GLOUR	(b) (6) _____(b) (6) GLOUR	08/19/1989 / /	210 100	12 40	58 STEEL	OPEN 58 - 210	OTHR	- - - -	Y	00383 HOME
0147SW 4 BLOUNT	94005036 D0007949	CENTRAL POINT BAPT CENTRAL PARK RD	11/19/1994 / /	660 310	7 --	63 STEEL	OPEN 63 - 660	OTHR	- - - -	Y	00385 HOME
0147SW 4 BLOUNT	95000749 D0012478	(b) (6) _____(b) (6) DEVAULT ROAD	02/08/1995 / /	130 105	40 60	63 STEEL	OPEN 63 - 130	GOOD	- - - -	Y	00536 HOME
0147SW 5 BLOUNT	00901190 LITTLE RIVER RD	(b) (6) _____(b) (6) LITTLE RIVER RD	11/10/1982 / /	175 160	30 70	43 STEEL	OPEN 43 - 175	GOOD	- - - -	Y	00383 HOME
0147SW 5 BLOUNT	00901378 ALCOA TRAIL	POPE'S PLANT_FA ALCOA TRAIL	10/23/1985 06/17/1986	145 80	25 30	32 STEEL	OPEN 32 - 145	GOOD	- - - -	Y	00622 IRR

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADRANGLE (0147SW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER USE
0147SW 5 BLOUNT	00901422	BREEDLOVE LARR ALCOA TRAILS	04/10/1986 / /	125 116	60 25	50 STEEL	OPEN -- -	GOOD	- - - -	- Y	00622 HOME
0147SW 5 BLOUNT	00901505	(b) (6) (b) (6) HOLLY BROOK	02/24/1987 / /	105 87	50 22	41 OTHER	41 - 105	GOOD	- - - -	- Y	00622 HOME
0147SW 5 BLOUNT	00901519	(b) (6) (b) (6) RUSSELL	09/09/1986 / /	225 210	-- 50	165 STEEL	OPEN 165 - 225	OTHR	- - - -	- Y	00383 HOME
0147SW 5 BLOUNT	00901551	(b) (6) (b) (6) OLD ROCKFORD	11/13/1986 / /	400 250	4 50	126 STEEL	OPEN 126 - 400	OTHR	- - - -	- Y	00383 HOME
0147SW 5 BLOUNT	00901610	WATSON ROGE SAM HOUSTON SCH	05/09/1988 / /	300 160	8 --	20 STEEL	OPEN 20 - 300	GOOD	- - - -	- Y	00622 HOME
0147SW 5 BLOUNT	00901698	GOODMAN BUST OLD KNOX HWY	10/12/1988 / /	125 65	28 37	41 STEEL	OPEN 42 - 125	GOOD	- - - -	- Y	00622 HOME
0147SW 5 BLOUNT	00901739	(b) (6) (b) (6) MARTIN MILL PIK	05/03/1989 / /	1073 236	9 30	41 STEEL	OPEN 41 - 1073	GOOD	- - - -	- Y	00622 HOME
0147SW 5 BLOUNT	92000016	(b) (6) (b) (6) ROCK RD	07/23/1991 / /	205 180	20 40	42 STEEL	OPEN 42 - 205	GOOD	- - - -	- Y	00031 HOME
0147SW 5 BLOUNT	92003412	PATTERSON RONA FOX HILLS	07/30/1992 / /	310 275	30 85	65 STEEL	OPEN 65 - 310	OTHR	- - - -	- Y	00383 HOME
0147SW 5 BLOUNT	93002546	POPES PLANT FARM ALCOA TRAIL	07/08/1993 4/18/1994	150 64	12 4	20 STEEL	OPEN 20 - 150	GOOD 008293	35-48-28 83-57-27	S Y	00622 IRR
0147SW 5 BLOUNT	93002551	POPES PLANT FARM ALCOA TRAIL	07/19/1993 4/18/1994	66 65	25 0	62 STEEL	OPEN 62 - 66	GOOD 008292	35-48-25 83-57-29	S Y	00622 IRR
0147SW 5 BLOUNT	93002930	POPES PLANT FARM ALCOA TRAIL	07/30/1993 4/18/1994	100 85	30 1	20 STEEL	OPEN 20 - 100	GOOD 008291	35-48-25 83-47-30	S Y	00622 IRR
0147SW 6 BLOUNT	00901181	MCMURRAY BOB HOLLYBROOK	04/25/1983 / /	225 205	15 90	42 STEEL	OPEN 42 - 225	GOOD	- - - -	- Y	00383 HOME
0147SW 6 BLOUNT	00901249	STEPHENS FRAN SELF HOLLOW	04/16/1984 / /	345 125	7 50	69 STEEL	OPEN 69 - 345	GOOD	- - - -	- Y	00383 HOME
0147SW 6 BLOUNT	00901353	WYATT RICH MARTINMILL PK	08/21/1985 / /	250 160	9 45	95 STEEL	OPEN 95 - 250	GOOD	- - - -	- Y	00622 HOME
0147SW 6 BLOUNT	00901372	TRENT JAKE HALLYBROOK	09/10/1985 06/17/1986	120 70	7 50	63 OTHER	OPEN 63 - 120	OTHR	35-47-30 83-52-30	- Y	00383 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADRANGLE (0147SW) TN.

QUAD / COUNTY	NTH REG NUM	WELL NUM LOCATION ROAD	OWNER'S NAME	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147SW 6 BLOUNT	00901528	DENTON _____ MARTIN MILL PIK	TERR	05/01/1982 / /	250 170	20 42	34 STEEL	OPEN 34 - 250	GOOD	- - - -	Y	00622 HOME
0147SW 6 BLOUNT	00901674	(b) (6) _____ HARRIS	(b) (6)	06/04/1988 / /	100 85	20 20	23 STEEL	OPEN 23 - 100	GOOD	- - - -	Y	00383 HOME
0147SW 6 BLOUNT	00901753	ROBINSON _____ HOLLYBROOK	EARL	04/19/1989 / /	290 160	12 60	65 STEEL	OPEN 65 - 290	OTHR	- - - -	Y	00383 HOME
0147SW 6 BLOUNT	00901786	WOODHALL _____ MARTIN MILL PIK	ALEC	03/17/1989 / /	350 210	15 90	44 STEEL	OPEN 44 - 350	GOOD	- - - -	Y	00031 HOME
0147SW 6 BLOUNT	90001631	(b) (6) _____ WILD WOOD RD	(b) (6)	05/21/1990 / /	310 108	12 9	39 STEEL	OPEN -- - --	GOOD	- - - -	N	00031 HOME
0147SW 6 BLOUNT	90003111	(b) (6) _____ GLOVER RD	(b) (6)	09/17/1990 / /	297 94	6 60	62 STEEL	OPEN 62 - 297	GOOD	- - - -	Y	00622 HOME
0147SW 6 BLOUNT	90003382	HINES _____ HOLLEYBROOK	AMY	07/31/1990 / /	100 70	30 25	49 STEEL	OPEN 49 - 100	OTHR	- - - -	Y	00383 HOME
0147SW 6 BLOUNT	92000562	(b) (6) _____ NAILS CREEK RD	(b) (6)	01/02/1992 / /	165 138	25 57	125 STEEL	OPEN 125 - 165	GOOD	- - - -	Y	00622 HOME
0147SW 6 BLOUNT	92002479	DONOVAN _____ / /	SHER	04/17/1992 / /	930 --	0 0	158 STEEL	OPEN 158 - 930	OTHR	- - - -	Y	00264 HOME
0147SW 6 BLOUNT	92002480	DONOVAN _____ / /	SHER	04/17/1992 / /	325 100	4 10	66 STEEL	OPEN 66 - 325	UNK	- - - -	Y	00264 HOME
0147SW 6 BLOUNT	92003411	BELL _____ CRESTNUT RIDGE	SCOT	09/02/1992 / /	350 325	20 40	105 STEEL	OPEN 105 - 350	OTHR	- - - -	Y	00383 HOME
0147SW 6 BLOUNT	92004007	BYRD _____ GLOVER	HERB	09/15/1992 / /	230 205	30 60	105 STEEL	OPEN 105 - 230	OTHR	- - - -	Y	00383 HOME
0147SW 6 BLOUNT	93002408	BRAKEBILL _____ MARTIN MILL PK	DON	03/10/1993 / /	425 350	15 70	84 STEEL	OPEN 84 - 425	OTHR	- - - -	Y	00383 HOME
0147SW 6 BLOUNT	94004053 D0007944	KIDD _____ MARTIN MILL 822	JERR	09/26/1994 6/ 6/1995	120 95	60 30	85 STEEL	OPEN 85 - 120	OTHR 008839	35-49-16 83-54-20	S Y	00385 HOME
0147SW 6 BLOUNT	94004364 D0008284	TARNEY _____ NORTH WILDWOOD	DONA	11/08/1994 / /	205 150	20 55	59 STEEL	OPEN 59 - 205	UNK	- - - -	Y	00536 HOME
0147SW 6 BLOUNT	94004682 D0010051	HARPER _____ MARTIN MILL PIK	ANDY	10/25/1994 6/ 6/1995	550 190	7 94	179 STEEL	OPEN 179 - 550	GOOD 008840	35-49-18 83-53-49	S Y	00622 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADRANGLE (0147SW) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147SW 6 BLOUNT	95000959 D0010176	(b) (6) _____ HOLLYBROOK 3742	(b) (6) 01/02/1995 6/ 6/1995	310 175	5 --	41 STEEL	41 - 310	OTHR 008837	35-39-45 83-54-33	F Y	00526 HOME
0147SW 6 BLOUNT	95002772 D0007883	(b) (6) _____ LYNNWOOD RD	(b) (6) 06/09/1995 / /	421 405	60 150	354 STEEL	OPEN 354 - 421	OTHR	- - - -	- Y	00385 HOME
0147SW 6 BLOUNT	95004784 D0014254	(b) (6) _____ GLOVER	(b) (6) 09/25/1995 / /	210 140	10 40	42 STEEL	42 - 210	OTHR	- - - -	- Y	00383 HOME
0147SW 6 BLOUNT	95005004 D0014727	BROWN _____ TIM	10/12/1995 / /	225 160	75 20	146 STEEL	OPEN 146 - 225	GOOD	- - - -	- Y	00264 HOME
0147SW 6 BLOUNT	95005006 D0014728	BROWN _____ TIM	10/16/1995 / /	345 250	-- 30	193 STEEL	OPEN 193 - 345	GOOD	- - - -	- Y	00264 HOME
0147SW 6 BLOUNT	96000998 D0016404	PICKLE _____ LARR MARTIN MILL PIK	03/07/1996 / /	665 440	7 60	20 STEEL	OPEN 20 - 665	UNK	- - - -	- Y	00536 HOME
0147SW 7 BLOUNT	00901011	ALCOA	08/01/1981 / /	73 --	-- --	52 STEEL	-- - --		35-46-58 83-58-10	S	00385 IND
0147SW 7 BLOUNT	00901012	ALCOA	07/31/1981 / /	-- --	-- --	6 STEEL	-- - --		35-47-10 83-58-23	S	00385 IND
0147SW 7 BLOUNT	00901013	ALCOA	07/31/1981 / /	-- --	-- --	43 STEEL	-- - --		35-47-09 83-58-23	S	00385 IND
0147SW 7 BLOUNT	00901014	ALCOA	07/30/1981 / /	48 --	-- --	6 STEEL	-- - --		35-47-07 83-58-11	S	00385 IND
0147SW 7 BLOUNT	00901015	ALCOA	07/29/1981 / /	75 --	-- --	60 STEEL	-- - --		35-47-05 83-58-10	S	00385 IND
0147SW 7 BLOUNT	00901016	ALCOA	07/28/1981 / /	39 --	-- --	21 STEEL	-- - --		35-47-13 83-58-20	S	00385 IND
0147SW 7 BLOUNT	00901017	ALCOA	07/28/1981 / /	70 --	-- --	46 STEEL	-- - --		35-47-12 83-58-18	S	00385 IND
0147SW 7 BLOUNT	00901018	ALCOA	07/27/1981 / /	50 --	-- --	21 STEEL	-- - --		35-46-59 83-58-11	S	00385 IND
0147SW 7 BLOUNT	00901019	ALCOA	07/27/1981 / /	66 --	-- --	52 STEEL	-- - --		35-46-57 83-58-32	S	00385 IND
0147SW 7 BLOUNT	00901020	ALCOA	07/24/1981 / /	60 --	-- --	22 STEEL	-- - --		35-46-56 83-58-30	S	00385 IND

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE MARYVILLE QUADRANGLE (0147SW) TN.

QUAD / COUNTY	NTH REG NUM	WELL NUM LOCATION ROAD	OWNER'S NAME	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147SW 7 BLOUNT	00901021	ALCOA		07/23/1981 / /	60 --	--	52 STEEL	-- - --		35-46-56 83-58-26	S	00385 IND
0147SW 7 BLOUNT	00901022	ALCOA		07/22/1981 / /	20 --	--	25 STEEL	-- - --		35-46-51 83-58-25	S	00385 IND
0147SW 7 BLOUNT	00901579	RADER _____ DISCO	SAM	07/13/1987 / /	200 145	15 60	105 STEEL	OPEN 105 - 200	OTHR	- - - -	Y	00383 HOME
0147SW 7 BLOUNT	00901724	SATTERFIELD _____ RIO VISTA	DENN	08/27/1988 / /	145 135	30 40	98 STEEL	OPEN 98 - 145	OTHR	- - - -	Y	00383 HOME
0147SW 7 BLOUNT	92000020	BOUNDS _____ GLOVER 1219	ROSA	11/01/1991 / /	310 --	--	-- STEEL	OPEN -- - --	GOOD	- - - -	Y	00031 HOME
0147SW 8 BLOUNT	00901195	HINE _____ MARSHALL	BURL	09/22/1982 / /	85 30	10 21	23 STEEL	OPEN 23 - 85	GOOD	- - - -	Y	00383 HOME
0147SW 8 BLOUNT	00901402	DELOZIER _____ SERVILLE	LYNN	09/18/1985 / /	225 126	25 --	70 STEEL	OPEN 70 - 225	OTHR	- - - -	Y	00383 HOME
0147SW 8 BLOUNT	00901630	WILLOCK _____ HWY 33	WILL	06/22/1988 / /	145 130	20 40	90 STEEL	OPEN 90 - 145	GOOD	- - - -	Y	00608 HOME
0147SW 8 KNOX	09302147	SMITH _____ PATTY	WADE	05/15/1989 / /	530 200	4 180	42 STEEL	OPEN 42 - 530	OTHR	- - - -	N	00152 HOME
0147SW 8 BLOUNT	95002777 D0007881	MCGRAW _____ HAZENWOOD	BERN	05/30/1995 / /	241 155	40 --	104 STEEL	OPEN 104 - 241	OTHR	- - - -	Y	00385 HOME
0147SW 9 BLOUNT	00901469	HITCH _____ DAVIS FORD	LYNN	09/08/1986 / /	145 124	12 88	120 STEEL	OPEN 120 - 145	GOOD	- - - -	Y	00622 HOME
0147SW 9 BLOUNT	00901705	HEADRICK _____ TUCKALEECHIE DR	RAY	10/12/1988 / /	165 140	10 40	73 STEEL	OPEN 73 - 165	OTHR	- - - -	Y	00608 HOME
0147SW 9 BLOUNT	00901752	ANDERSON _____ HELTON	DON	04/23/1989 / /	350 327	10 60	56 STEEL	OPEN 56 - 350	OTHR	- - - -	Y	00383 HOME
0147SW 9 BLOUNT	92002313	YOUNG _____ PINEY GROVE	PATT	11/22/1991 / /	190 175	25 15	42 STEEL	OPEN 42 - 190	UNK	- - - -	Y	00383 HOME
0147SW 9 BLOUNT	92003404	SWAFFORD _____ DAVIS FORD	JOE	06/03/1992 / /	125 100	20 90	41 STEEL	OPEN 41 - 125	OTHR	- - - -	Y	00383 HOME
0147SW 9 BLOUNT	96000102 D0007915	CLARK _____ BLAZIER RD	BARB	10/16/1995 / /	520 256	3 --	59 STEEL	OPEN 59 - 520	OTHR	- - - -	Y	00385 HOME

" Water Wells on the Shooks Gap Quadrangle "

TDEC/DWS. 1997c. Records of Water Wells on the Shooks Gap Quadrangle
(0147NE) TN. November 12. Pp.:1-12.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

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TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / COUNTY	NTH REG NUM	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NE 1 KNOX	09300148	EDITION N	11/04/1964 / /	94 50	5 --	20 STEEL	-- --	--		-- --		00031 HOME
0147NE 1 KNOX	09301510	CARSON H.	06/05/1981 / /	150 100	10 25	21 STEEL	-- --	--	GOOD	35-58-19 83-51-45	S	00115 HOME
0147NE 1 KNOX	09301620	BROWN GEORGE	09/00/1982 / /	320 --	20 --	80 STEEL	-- --	--	GOOD	35-58-12 83-51-34	S	00138 HOME
0147NE 1 KNOX	09301637	WEIGEL RIVERSHORE1659	KREI 02/02/1983 / /	125 115	25 30	51 STEEL	-- --	--	BAD	35-59-19 83-50-53	S	00385
0147NE 1 KNOX	09301728	WEIGLE____FRAN 2134 ASBURY RD	01/04/1984 / /	280 260	60 --	21 STEEL	OPEN 21 -	280	GOOD	35-57-30 83-50-00	M Y	00264 HEAT
0147NE 1 KNOX	09301729	WEIGLE____FRAN 2134 ASBURY RD	01/03/1984 / /	530 350	7 --	21 STEEL	OPEN 21 -	530	GOOD	35-57-30 83-50-00	M Y	00264
0147NE 1 KNOX	09301771	SOLOMAN____ALAN RIVER BEND	06/11/1984 / /	350 340	100 80	105 STEEL	OPEN 105 -	350	GOOD	-- -- -- --		00383 HOME
0147NE 1 KNOX	09309141	JOHNSON W M 0-17917	/ /19 / /	120 108	-- 15	30	-- --	--	GOOD	35-58-23 83-52-18	S	HOME
0147NE 1 KNOX	09309142	JOHNSON W M 0-17917	/ /19 / /	110 --	-- 16	25	-- --	--	UNK	35-58-20 83-52-06	S	HOME
0147NE 1 KNOX	09309149	WEIGEL F A 0-161-16	/ /19 / /	225 --	-- --	-- STEEL	-- --	--	UNK	35-59-00 83-51-12	S	HOME
0147NE 1 KNOX	09309150	WEIGEL F A SR 0-159	/ /19 / /	150 --	-- 30	40	-- --	--	UNK	35-58-01 83-50-40	S	OTHR
0147NE 1 KNOX	90000733	CONWAY____KARE WEIGEL LN	03/08/1990 / /	283 151	12 4	62 STEEL	OPEN 62 -	283	UNK	-- -- -- --		00385 HOME
0147NE 1 KNOX	97000077 D0022600	CATE____MIKE ARCHIE WIEGEL	12/08/1996 / /	625 425	4 200	89 STEEL	OPEN 89 -	625	UNK	-- -- -- --		00536 HOME
0147NE 1 KNOX	97002736 D0027152	AMERICAN BUILDERS O P PICKLE	07/16/1997 / /	510 410	8 180	63 STEEL	OPEN 63 -	510	OTHR	-- -- -- --		00115 HOME
0147NE 2 KNOX	09300203	WILHAIT L	08/25/1965 / /	84 80	30 20	39 STEEL	-- --	--		-- -- -- --		00216 HOME
0147NE 2 KNOX	09300457	CLINE J	11/24/1968 / /	130 45	10 45	20 STEEL	-- --	--	GOOD	35-58-57 83-49-10	S	00153 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER HOME
0147NE 2 KNOX	09301616	WELCH JAMES	09/08/1982 / /	145 117	15 40	61 STEEL	--- --	GOOD	35-59-06 83-48-43	S	00385 HOME
0147NE 2 KNOX	09301720	FIELDEN _____ JOHN SEVIER	11/03/1983 / /	180 140	3 --	63 STEEL	OPEN 63 - 180	OTHR	35-55-00 83-45-00	M N	00138 HOME
0147NE 2 KNOX	09301747	MACKEY _____ PERRY RD	07/03/1984 / /	220 200	3 --	94 STEEL	OPEN 94 - 220	GOOD	- - - -	Y	00138 HOME
0147NE 2 KNOX	09302080	HODGE _____ PRATE RD	06/06/1988 / /	150 121	20 21	20 STEEL	OPEN --- --	GOOD	- - - -	Y	00031 HOME
0147NE 2 KNOX	09309143	LUSBY _____ MOSHINA RD	J C / /19	51 --	-- 20	-- STEEL	OPEN 14 - 51	UNK	35-59-28 83-47-52	S N	00000 HOME
0147NE 2 KNOX	09309145	TERRY4A R 0-1680-16	/ /19 / /	122 --	-- 40	6 ---	---	UNK	35-58-06 83-47-54	S	HOME
0147NE 2 KNOX	09309146	MAYNARD J F 0-16716	/ /19 / /	60 --	10 2	-- ---	---	UNK	35-58-48 83-49-18	S	IND
0147NE 2 KNOX	09309147	MAYNARD J F 0-16716	/ /19 / /	100 100	35 --	-- ---	---	UNK	35-58-48 83-49-18	S	
0147NE 2 KNOX	09309148	ARMSTRONG R 0-16	/ /19 / /	104 102	-- 20	-- ---	---	UNK	35-59-34 83-49-42	S	HOME
0147NE 2 KNOX	95005784 D0015890	ATCHLEY _____ BELLA VISTA LAN	JODI 12/08/1995 / /	210 90	10 50	41 STEEL	OPEN 41 - 210	GOOD	- - - -	Y	00667 HOME
0147NE 3 KNOX	09300353	DELOZIER C	07/27/1967 / /	132 130	20 75	77 STEEL	---	GOOD	35-59-13 83-45-26	S	00385 HOME
0147NE 3 KNOX	09300367	WHITTLE B KODACK OFF	12/04/1968 / /	770 760	2 500	60 STEEL	---	GOOD	35-59-04 83-44-59	S	00152 HOME
0147NE 3 KNOX	09300456	TERRY D.	10/15/1968 / /	225 95	95	20 STEEL	---	GOOD	35-59-00 83-46-42	S	00153 HOME
0147NE 3 KNOX	09300584	PERRY BILL	00/00/1970 / /	212 190	20 --	123 STEEL	---	GOOD	35-59-24 83-45-05	S	00182
0147NE 3 KNOX	09301189	MYNATT F	10/25/1977 / /	400 365	10 80	110 STEEL	---	GOOD	35-59-07 83-45-18	S	00031 HOME
0147NE 3 KNOX	09301623	RICKLE	00/00/1982 / /	280 --	5 60	72 STEEL	---	GOOD	35-59-16 83-46-29	S	HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NE 3 KNOX	09301926	DUNN MIKE NORWOOD	02/12/1987 / /	410 410	3 300	42 STEEL	OPEN 42 - 410	OTHR	- - - -	-	00115 HOME
0147NE 3 KNOX	09308001	NO NAME	/ /19 / /	-- --	10 --	--	--	GOOD	35-59-25 83-52-07	S	FARM
0147NE 3 KNOX	09308003	KELLY JOE B GS	/ /19 / /	-- --	20 --	--	--	GOOD	35-57-46 83-45-54	S	FARM
0147NE 3 KNOX	09309144	MASTERTSON R T 0-165	/ /19 / /	168 96	5	147	--	GOOD	35-59-21 83-45-58	S	HOME
0147NE 3 KNOX	09309154	HODGES BERT 0-14814	/ /19 / /	116 50	--	--	--	UNK	35-57-30 83-46-15	S	HOME
0147NE 3 KNOX	09309161	KELLY JOE B	00/00/1940 / /	200 170	25 30	35 STEEL	--	GOOD	35-57-49 83-45-49	S	FARM
0147NE 3 SEVIER	15500496	THORPE A	04/09/1966 / /	122 60	3 55	10 STEEL	--	GOOD	35-57-34 83-45-11	S	00154 FARM
0147NE 3 SEVIER	15500497	MOORE R	05/13/1966 / /	100 80	5 60	21 STEEL	--		35-57-48 83-45-44	S	00154 HOME
0147NE 3 SEVIER	15500541	SHEPHARD R	08/05/1966 / /	300 285	12 110	70 STEEL	--	GOOD	35-57-50 83-46-01	S	00152 HOME
0147NE 3 SEVIER	15500593	YETT C	07/21/1966 / /	154 145	10 40	17 STEEL	--	UNK	35-57-39 83-45-33	S	00078 HOME
0147NE 3 KNOX	93000261	NANCE BOB	08/15/1992 / /	205 115	75 25	61 STEEL	62 - 205	OTHR	- - - -	-	00264 HOME
0147NE 3 KNOX	95000728 D0009436	RUSSELL RON	02/01/1995 / /	225 160	15 80	146 STEEL	OPEN 146 - 225	UNK	- - - -	-	00264 HOME
0147NE 3 KNOX	97000378 D0022219	BROOKS MR T JOHN SEVIER HIG	01/02/1997 / /	401 152	20 --	84 STEEL	OPEN 84 - 401	OTHR	- - - -	-	00385 HOME
0147NE 4 KNOX	09300132	CARPENTER F	09/15/1964 / /	100 60	10 35	25 STEEL	--		- - - -	-	00031
0147NE 4 KNOX	09300321	BERRIER E	04/20/1967 / /	354 317	12 165	50 STEEL	--	GOOD	35-55-25 83-50-15	S	00385 HOME
* 0147NE 4 KNOX	09300390	HURST J DANIEL LN4217	02/17/1968 / /	190 40	-- 150	21 STEEL	--	GOOD	- - - -	-	00241 HOME

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TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NE 4 KNOX	09301672	CONNER_____RAY_ BURNETTE CREEK	06/02/1983 08/08/1983	165 40	2 42	34 STEEL	OPEN 34 - 165	GOOD	35-56-08 83-50-23	S Y	00385 HOME
0147NE 4 KNOX	09301881	COUNTISS_____RONN FRAZER RD	01/14/1986 / /	200 168	11 50	20 STEEL	OPEN 20 - 200	GOOD	- - - -	- Y	00031 HOME
0147NE 4 KNOX	09309152	MCMILLAN A J 0-1525	/ /19 / /	120 --	-- 60	-- --	-- - --	UNK	35-55-34 83-51-35	S	HOME
0147NE 4 KNOX	94005048 D0007857	DEW JR_____ADRI NIXON ROAD	11/31/1994 / /	301 87	6 --	70 STEEL	OPEN 70 - 301	OTHR	- - - -	- Y	00385 HOME
0147NE 5 KNOX	09300030	HARIS R	11/04/1963 / /	111 --	-- 66	21 STEEL	-- - --	GOOD	35-57-05 83-48-13	S	00241 HOME
0147NE 5 KNOX	09300198	CLARK T	08/19/1965 / /	151 140	-- 50	59 STEEL	-- - --	GOOD	35-56-06 83-48-00	S	00293 HOME
0147NE 5 KNOX	09300218	FLANAGIN J	10/28/1965 / /	145 125	-- 60	27 STEEL	-- - --	GOOD	35-55-20 83-48-49	S	00293 HOME
0147NE 5 KNOX	09300240	CLARK A	03/23/1966 / /	339 --	-- 120	121 STEEL	-- - --	GOOD	35-57-05 83-48-10	S	00241 HOME
0147NE 5 KNOX	09301368	TUCKER FABRICATORS	05/24/1979 / /	130 105	30 --	33 STEEL	-- - --	GOOD	- - - -	-	00264 COMM
0147NE 5 KNOX	09301509	NEW HOPEWELL B.CH.	06/09/1981 / /	610 384	30 30	21 STEEL	-- - --	GOOD	35-55-43 83-48-05	S	00385
0147NE 5 KNOX	09301551	BURLAH METHODIST CH	12/30/1981 / /	250 222	55 40	42 STEEL	-- - --	GOOD	35-55-43 83-48-25	S	00385
0147NE 5 KNOX	09301552	NEW HOPEWELL CHURCH	09/10/1981 / /	518 --	-- --	21 STEEL	-- - --	GOOD	35-55-44 83-48-03	S	00385 MDOM
0147NE 5 KNOX	09301553	NEW HOPEWELL B.CH.	09/08/1981 / /	579 553	30 --	42 STEEL	-- - --	GOOD	35-55-44 83-48-06	S	00385 MDOM
0147NE 5 KNOX	09301600	HARRIS FRENCH	06/18/1982 / /	272 205	-- 62	41 STEEL	-- - --	GOOD	35-56-40 83-47-44	S	00385 HOME
0147NE 5 KNOX	09301615	ROBERTS K.	08/15/1982 / /	475 175	3 120	41 STEEL	-- - --	GOOD	35-55-02 83-48-34	S	00385 HOME
0147NE 5 KNOX	09301666	CLARK_____A.L. OLD FRENCH	04/08/1983 08/08/1983	969 126	-- 61	118 STEEL	OPEN 118 - 969	GOOD	35-57-08 83-48-07	S Y	00385 OTHR

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NE 5 KNOX	09301878	DUNN _____ MIKE NORWOOD RD	03/18/1986 / /	350 350	1 40	33 STEEL	OPEN 33 - 350	OTHR	- - - -	-	00115 HOME
* 0147NE 5 KNOX	09301957	CHESTER _____ THOM FORD TOWN RD	03/03/1987 / /	105 96	40 47	52 STEEL	OPEN -- - --	GOOD	- - - -	-	00622 HOME
0147NE 5 KNOX	09309151	SHENKS C M 0-154-15	/ /19 / /	78 --	-- 32	30	-- - --	UNK	36-56-08 83-49-45	S	HOME
0147NE 5 KNOX	09309153	BURNETT H B 0-15015	/ /19 / /	70 --	-- 40	25 STEEL	-- - --	UNK	36-55-23 83-48-56	S	HOME
0147NE 5 KNOX	09309162	DEADRICKK	00/00/1948 / /	270 220	15 65	40 STEEL	-- - --	GOOD	35-55-24 83-55-24	S	HOME
0147NE 5 KNOX	09309163	CARVER ROBERT	00/00/1950 / /	167 60	25 20	20 STEEL	-- - --	GOOD	35-55-26 83-47-44	S	OTHR
0147NE 5 KNOX	90000493	CLARK _____ A L JOHN SEVIER HWY	10/02/1988 / /	265 151	60 2	73 STEEL	OPEN 73 - 265	H2S	- - - -	-	00385 HEAT
0147NE 5 KNOX	93004751	BURNETT _____ ACE NEW FRENCH RD	09/14/1993 4/28/1994	162 95	60 30	-- STEEL	OPEN -- - --	GOOD 008300	35-56-27 83-47-42	S N	00385 HOME
0147NE 5 KNOX	94005044	KELLEY _____ CLYD D0007851 DAVIS ROAD	11/21/1994 / /	140 105	12 --	63 STEEL	OPEN 63 - 140	OTHR	- - - -	-	00385 HOME
0147NE 5 KNOX	95002774	GIBBS _____ JOE D0007878 FRENCH RD	05/12/1995 / /	660 330	4 160	21 STEEL	OPEN 21 - 660	OTHR	- - - -	-	00385 HOME
0147NE 5 KNOX	95004015	CAMPBELL _____ STEV D0007897 DEADRICK ROAD	08/14/1995 / /	180 90	30 --	42 STEEL	OPEN 42 - 180	OTHR	- - - -	-	00385 HOME
0147NE 5 KNOX	96004997	BURNETT _____ JERR D0018675 KIMBERLIN HGTS	10/31/1996 2/16/1997	300 180	15 100	21 STEEL	OPEN 21 - 300	UNK 018345	35-55-37 83-47-37	S Y	00684 HOME
0147NE 5 KNOX	97001025	BROOKS _____ TONY D0020205 JOHN SEVIER HIG	03/04/1997 / /	201 62	25 --	49 STEEL	OPEN 49 - 201	OTHR	- - - -	-	00385 HOME
0147NE 5 KNOX	97003329	CLARK _____ RAY D0022177 OLD FRENCH RD	05/08/1997 / /	280 265	20 --	42 STEEL	OPEN 42 - 280	OTHR	- - - -	-	00385 HOME
0147NE 5 KNOX	97003334	SHIPE _____ CLAU D0022182 JOHN SEVIER HWY	06/12/1997 / /	100 36	25 --	31 STEEL	OPEN 31 - 100	OTHR	- - - -	-	00385 HOME
0147NE 6 KNOX	09300027	CRUZE S	08/25/1963 / /	80 --	-- 20	10 STEEL	-- - --		35-55-55 83-46-10	S	00093 HOME

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TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NE 6 KNOX	09300028	INMAN F	08/15/1963 / /	90 --	-- 35	36 STEEL	-- - --		35-55-03 83-46-53	S	00093 HOME
0147NE 6 KNOX	09300037	CLARK & HOLMS B	12/18/1963 / /	112 --	-- 40	23 STEEL	-- - --	GOOD	35-55-20 83-45-20	S	00241 HOME
0147NE 6 KNOX	09300059	PIERCE J	04/20/1964 / /	235 210	25 160	112 STEEL	-- - --		35-57-25 83-46-05	S	00138 HOME
0147NE 6 KNOX	09300060	POTTERFIELD H	04/16/1964 / /	110 80	10 --	44 STEEL	-- - --		35-55-10 83-45-55	S	00031 HOME
0147NE 6 KNOX	09300080	ROBINSON NEWHOPEWELL	07/07/1964 / /	87 --	-- 20	21 STEEL	-- - --		- - - -		00031 HOME
0147NE 6 KNOX	09300093	DODSON R	08/07/1964 / /	160 --	-- 75	34 STEEL	-- - --	GOOD	35-55-33 83-45-58	S	00241 HOME
0147NE 6 KNOX	09300094	ANDERSON F	08/13/1964 / /	165 --	-- 80	25 STEEL	-- - --	GOOD	35-56-22 83-45-55	S	00241 HOME
0147NE 6 KNOX	09300210	WILFORD	09/22/1965 / /	164 150	-- 50	37 STEEL	-- - --	GOOD	35-56-25 83-45-53	S	00293 HOME
0147NE 6 KNOX	09300217	BOLING B	11/04/1965 / /	210 205	-- 70	23 STEEL	-- - --	GOOD	35-56-06 83-46-11	S	00293 HOME
0147NE 6 KNOX	09300219	DODSON O	11/08/1965 / /	112 105	-- 72	45 STEEL	-- - --	GOOD	35-55-50 83-45-47	S	00293 HOME
0147NE 6 KNOX	09300224	NOE B	11/17/1965 / /	165 160	-- 70	39 STEEL	-- - --	GOOD	35-55-25 83-46-10	S	00293 HOME
0147NE 6 KNOX	09300225	HENDERSON A KIMBERLIN HEIGHT	11/27/1965 / /	202 190	-- 80	18 STEEL	-- - --	GOOD	- - - -		00293 HOME
0147NE 6 KNOX	09300230	HENRY L	01/20/1966 / /	135 --	-- 65	23 STEEL	-- - --	GOOD	35-56-32 83-45-49	S	00241 HOME
0147NE 6 KNOX	09300329	VALENTINE B	04/19/1967 / /	376 265	-- 20	144 STEEL	-- - --	GOOD	35-55-33 83-45-56	S	00293 HOME
0147NE 6 KNOX	09300352	JACK H	08/03/1967 / /	117 105	20 --	54 STEEL	-- - --	GOOD	35-56-57 83-47-11	S	00385 HOME
0147NE 6 KNOX	09300356	BOILING K	09/08/1967 / /	127 115	-- 30	45 STEEL	-- - --	GOOD	35-56-47 83-45-56	S	00293 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSP DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NE 6 KNOX	09300449	BOILING H	11/09/1968 / /	107 95	-- 20	44 STEEL	-- - --	GOOD	35-55-49 83-45-35	S	00293 HOME
0147NE 6 KNOX	09300450	BOILING H	11/01/1968 / /	125 120	-- 50	35 STEEL	-- - --	GOOD	35-55-49 83-45-35	S	00293 HOME
0147NE 6 KNOX	09300596	COLE FRED	08/20/1970 / /	93 80	-- 40	28 STEEL	-- - --	GOOD	35-55-32 83-46-29	S	00293 HOME
0147NE 6 KNOX	09300599	MIZE JAMES	07/10/1970 / /	293 285	-- 80	25 STEEL	-- - --	GOOD	35-55-27 83-46-56	S	00293 HOME
0147NE 6 KNOX	09300625	WRINKLE LLOYD	11/29/1970 / /	115 95	16 40	30 STEEL	-- - --		35-56-34 83-46-18	S	00241 HOME
0147NE 6 KNOX	09300626	COVINGTON	12/21/1970 / /	100 85	18 45	22 STEEL	-- - --		35-56-33 83-46-15	S	00241 HOME
0147NE 6 KNOX	09300662	WARRENRPAUL F	11/01/1971 / /	328 300	3 67	56 STEEL	-- - --	GOOD	35-55-21 83-46-23	S	00028 HOME
0147NE 6 KNOX	09301586	BROCK GARY	06/10/1982 / /	340 320	8 75	60 STEEL	-- - --	GOOD	35-55-54 83-45-35	S	00138 HOME
0147NE 6 KNOX	09301614	MILLER JIM	08/05/1982 / /	270 257	25 35	42 STEEL	-- - --	GOOD	35-55-55 83-45-40	S	00385 HOME
0147NE 6 KNOX	09301704	BREEDEN _____ PAUL LUNDY LANE	08/08/1983 12/29/1983	251 160	6 160	62 STEEL	OPEN 62 - 251	GOOD	35-55-37 83-46-53	S Y	00385 HOME
0147NE 6 KNOX	09302086	HUTTELL _____ TIM HOLSTON RIVER R	05/31/1988 / /	510 250	3 80	62 STEEL	OPEN 62 - 510	GOOD	- - - - - -	- Y	00536 HOME
0147NE 6 KNOX	09309155	HODGES C 0-147 0-14	/ /19 / /	110 110	-- 20	18	-- - --	UNK	35-56-08 83-47-04	S	HOME
0147NE 6 KNOX	09309156	NO NAME	/ /19 / /	142 120	20 20	42 STEEL	-- - --	UNK	35-55-49 83-45-06	S	HOME
0147NE 6 KNOX	09309164	CLARK	00/00/1955 / /	66 50	15 30	20 STEEL	-- - --	GOOD	35-55-20 83-47-26	S	HOME
0147NE 6 KNOX	09309165	KING J C	00/00/1952 / /	129 65	20 110	9 STEEL	-- - --	GOOD	35-56-44 83-46-09	S	FARM
0147NE 6 KNOX	09309166	DODSON PAUL	00/00/1940 / /	110 85	10 60	40 STEEL	-- - --	GOOD	35-55-30 83-45-59	S	HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NE 6 KNOX	90000481	ANDRE _____ MR. HODGES FERRY RD	07/26/1989 / /	501 342	11 31	62 STEEL	OPEN 62 - 501	OTHR	- - - -	- Y	00385 HOME
0147NE 6 KNOX	90000498	ASHLEY JR _____ C_E_ KIMBERLIN HGTS	12/07/1989 / /	202 125	17 5	142 STEEL	OPEN 142 - 202	OTHR	- - - -	- Y	00385 HOME
0147NE 6 KNOX	90001083	PARROTT _____ BURL 8814 BERYL LANE	03/13/1990 / /	230 101	12 9	20 STEEL	OPEN 20 - 230	GOOD	- - - -	- Y	00031 HOME
0147NE 6 KNOX	90003598	SCRIVNER _____ ALVI / /	05/10/1990 / /	410 370	15 100	104 STEEL	OPEN 104 - 410	UNK	- - - -	- Y	00264 HOME
0147NE 6 KNOX	91001166	ANDERSON _____ WILF DOTSON RD	04/18/1991 / /	140 110	6 10	41 STEEL	OPEN -- - --	GOOD	- - - -	- Y	00692 HOME
0147NE 6 KNOX	92002425	WILSON _____ JIM / /	06/01/1992 / /	460 260	10 60	104 STEEL	OPEN 104 - 460	GOOD	- - - -	- Y	00536 HOME
0147NE 6 KNOX	93002870	COREEN _____ MIKE SEVIERVILLE PK	06/29/1993 / /	405 340	4 180	20 STEEL	OPEN 20 - 405	OTHR	- - - -	- Y	00264 HOME
0147NE 6 SEVIER	93002964	WATERS _____ ERNE PROVIDENCE	07/10/1993 / /	184 150	15 85	84 STEEL	OPEN 84 - 184	GOOD	- - - -	- Y	00152 HOME
0147NE 6 KNOX	94003273 D0006546	RIDGEWAY BAPTIST CH 3515 KIMBERLING	03/17/1994 / /	265 140	10 --	148 STEEL	OPEN 148 - 265	GOOD	- - - -	- Y	00692 HOME
0147NE 6 KNOX	95005174 D0007912	JOHNSON _____ VICK HANKINS ROAD	10/09/1995 / /	120 81	20 48	69 STEEL	OPEN 69 - 120	OTHR	- - - -	- Y	00385 HOME
0147NE 6 KNOX	96002935 D0018585	CATES _____ ROY WEIGEL LN	06/25/1996 / /	205 180	30 60	99 STEEL	OPEN 99 - 205	UNK	- - - -	- Y	00536 HOME
0147NE 6 KNOX	97001389 D0023578	PARROTT _____ RICH KIMBERLIN HGTS	04/24/1997 / /	645 200	20 115	175 STEEL	OPEN 175 - 645	OTHR	- - - -	- Y	00264 HOME
0147NE 7 KNOX	09300357	FORD F NEUBERTSQUARRY	09/21/1967 / /	214 175	112 150	155 STEEL	33 - 78	GOOD	- - - -	-	00385 HOME
0147NE 7 KNOX	09300487	PATTERSON J	04/19/1969 / /	115 18	-- 97	22 STEEL	-- - --	GOOD	35-53-50 83-52-07	S	00241 HOME
0147NE 7 KNOX	09300496	WRIGHT D THOMPSON SCHOOL	05/23/1969 / /	160 145	75 30	21 STEEL	-- - --	GOOD	- - - -	-	00028 HOME
0147NE 7 KNOX	09301250	DRUMMOND TARWATER	07/00/1978 / /	200 --	5 50	43 STEEL	-- - --	GOOD	35-53-08 83-51-55	S	00138 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NE 7 KNOX	09301772	PRATER _____ W_H PRATER	02/14/1983 / /	250 155	4 60	63 STEEL	OPEN 63 - 250	GOOD	- - - -	-	00383 HOME
0147NE 7 KNOX	09301847	JETT _____ ROND TARKLIN VALLEY	10/15/1985 / /	195 195	6 150	21 STEEL	OPEN 21 - 195	OTHR	- - - -	Y	00115 HOME
0147NE 7 KNOX	09308005	NEUBERT SULPHUR SPR	/ /19 / /	-- --	100 --	--	--	GOOD	- - - -	-	-
0147NE 7 KNOX	09309158	CRUZESB H 0-1420-14	/ /19 / /	70 --	-- 30	30 STEEL	-- - --	UNK	35-52-54 83-50-45	S	HOME
0147NE 7 KNOX	09309159	KRAPF4R C 0-1410-14	/ /19 / /	92 65	-- 30	16 STEEL	-- - --	UNK	35-53-49 83-52-24	S	-
0147NE 7 KNOX	09309168	COOPER JAMES P	00/00/1957 / /	360 340	50 90	40 STEEL	-- - --	GOOD	35-53-09 83-50-10	S	FARM
0147NE 7 KNOX	09309169	MIKELS RUFUS	00/00/1952 / /	52 20	500 30	20 STEEL	-- - --	GOOD	35-52-58 83-50-08	S	FARM
0147NE 7 KNOX	90000472	MONDAY _____ DON_ JOHN SEVIER HWY	06/20/1989 / /	245 197	100 6	126 STEEL	OPEN 126 - 245	OTHR	- - - -	Y	00385 IRR
0147NE 7 KNOX	90000727	MONDAY _____ DON_ JOHN SEVIER HWY	06/20/1989 / /	245 130	60 4	125 STEEL	OPEN 125 - 245	UNK	- - - -	Y	00385 IRR
0147NE 7 KNOX	93001052	PRICE _____ MIKE RUDDER RD	11/12/1992 / /	420 400	40 90	84 STEEL	OPEN 84 - 420	GOOD	- - - -	Y	00536 HOME
0147NE 7 KNOX	93004736	CRUZE _____ KEVI 8402SPANGLER	06/26/1993 4/28/1994	240 211	30 50	105 STEEL	OPEN 105 - 240	OTHR 008304	35-52-35 83-50-37	S Y	00385 HOME
0147NE 7 KNOX	95005177 D0007915	PRIEST _____ RAYM TARWATER ROAD	10/20/1995 / /	-- 58	-- --	39 STEEL	OPEN 39 - 39	OTHR	- - - -	Y	00385 HOME
0147NE 8 BLOUNT	00901290	WALKER _____ GERA PICKENS GAP	09/12/1983 04/05/1984	515 292	8 220	83 STEEL	OPEN 83 - 515	GOOD	35-52-42 83-48-31	F Y	00385 HOME
0147NE 8 BLOUNT	00901785	FRANKENBURG _____ ART DAY FARM RD	07/28/1989 / /	425 180	7 --	48 STEEL	-- - 425	GOOD	- - - -	Y	00031 HOME
0147NE 8 KNOX	09300192	PATTERSON O KIMBERLIN HGTS	11/26/1969 / /	147 140	-- 75	77 STEEL	-- - --	GOOD	- - - -	-	00450 HOME
0147NE 8 KNOX	09300520	BOWERS B	07/23/1969 / /	310 300	-- 140	85 STEEL	-- - --	GOOD	35-53-20 83-48-17	S	00209 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NE 8 KNOX	09300521	H V MEMORIAL GARDEN	06/12/1969 / /	182 179	116 80	66 STEEL	-- -- --	GOOD	35-53-38 83-48-06	S	00209 COMM
0147NE 8 KNOX	09300591	VEAL CLIFFORD	04/09/1970 / /	165 150	30 115	130 STEEL	-- -- --	GOOD	35-53-46 83-48-26	S	00152 HOME
0147NE 8 KNOX	09300594	WHALEY KENNETH	09/11/1970 / /	225 210	-- 60	97 STEEL	-- -- --	GOOD	35-53-12 83-49-10	S	00293 HOME
0147NE 8 KNOX	09300595	DELOZIER MAMIE	08/26/1970 / /	121 100	-- 20	38 STEEL	-- -- --	GOOD	35-53-45 83-49-09	S	00293 HOME
0147NE 8 KNOX	09301233	DOYLE C	07/14/1978 / /	128 56	16 --	42 STEEL	-- -- --	GOOD	-- -- --		00385 HOME
0147NE 8 KNOX	09301568	THATCHER J.R.	06/29/1981 / /	277 200	15 35	40 STEEL	-- -- --	GOOD	35-53-50 83-49-40	S	00589 IND
0147NE 8 KNOX	09301691	INGLE _____ MAPLES	08/18/1983 / /	100 80	25 35	42 STEEL	OPEN 42 - 100	GOOD	35-55-00 83-40-00	M Y	00138 HOME
0147NE 8 KNOX	09301958	CEDAR_RUN_FARM_ OLD BROOK HAVEN	03/06/1987 / /	550 210	7 18	54 STEEL	OPEN -- -- --	GOOD	-- -- --		00622 HOME
0147NE 8 KNOX	09301982	SHULER _____ LOUI MERRY LANE	04/13/1987 / /	310 310	15 140	220 STEEL	OPEN 220 - 310	OTHR	-- -- --		00115 HOME
0147NE 8 KNOX	09308004	CARTERSWCAVE SPR GS	/ /19 / /	-- --	620 --	--	-- -- --	GOOD	35-52-46 83-49-30	S	HOME
0147NE 8 KNOX	09309157	CALDWELL E 0-14	/ /19 / /	135 126	-- 35	20	-- -- --	UNK	35-54-00 83-49-14	S	HOME
0147NE 8 KNOX	09309170	MANES WADE P	00/00/1955 / /	70 50	20 30	20 STEEL	-- -- --	GOOD	35-52-50 83-49-50	S	HOME
0147NE 8 SEVIER	15505347	RODGER _____ HERM CHATMAN HWY	03/30/1988 / /	350 161	8 80	47 STEEL	OPEN 47 - 350	GOOD	-- -- --		00031 HOME
0147NE 8 SEVIER	15505349	ELLIS _____ DAVI INDIAN WAR PATH	01/04/1988 / /	300 280	10 250	125 STEEL	OPEN 125 - 300	GOOD	-- -- --		00031 HOME
0147NE 8 SEVIER	90000486	GODSY _____ MR_R NEWELL CIRCLE	01/31/1989 / /	460 216	12 10	113 STEEL	OPEN 113 - 460	OTHR	-- -- --		00385 HOME
0147NE 8 BLOUNT	92002329	TURNER _____ JOE COLD SPRINGS	04/20/1992 / /	145 80	20 5	21 STEEL	OPEN 21 - 145	OTHR	-- -- --		00383 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG	DRILLER USE
0147NE 8 KNOX	93004116	SEXTON _____ JOHN	05/29/1993 / /	530 380	6 80	139 STEEL	OPEN 139 - 530	UNK	- - - -	-	00264 HOME
0147NE 8 SEVIER	93005260 D0006536	BAYS MTN COUNTRY CL	12/01/1993 / /	315 295	15 --	62 STEEL	OPEN 62 - 315	GOOD	- - - -	Y	00692 IRR
0147NE 8 BLOUNT	95002778 D0007861	LAKEWAY ACADEMY SER PICKENS GAP RD	06/02/1995 / /	680 105	20 0	42 STEEL	OPEN 42 - 680	GOOD	- - - -	Y	00385 COMM
0147NE 8 SEVIER	96004184 D0024003	KENDRICK _____ STEV CHAMBERLAIN WAY	09/09/1996 / /	260 180	8 80	20 STEEL	OPEN 20 - 260	OTHR	- - - -	Y	00720 HOME
0147NE 9 KNOX	09300531	CARTER B	09/29/1969 / /	228 165	-- 128	32 STEEL	-- - --	GOOD	35-53-58 83-47-30	S	00293 HOME
0147NE 9 KNOX	09300647	MARSHONNC.R	07/13/1976 / /	123 35	-- 35	27 STEEL	-- - --	GOOD	- - - -		00400 HOME
0147NE 9 KNOX	09301576	PATTERSON LOY	03/23/1982 / /	150 145	7 80	61 STEEL	-- - --	GOOD	35-54-14 83-46-40	S	00580 HOME
0147NE 9 KNOX	09301688	NEWCOMB _____ MIKE	08/19/1983 10/24/1983	140 120	40 --	21 STEEL	OPEN 21 - 140	GOOD	35-54-15 83-46-38	S Y	00264 HOME
0147NE 9 KNOX	09309167	LOWE R	00/00/1950 / /	250 220	30 60	30 STEEL	-- - --	GOOD	35-54-39 83-46-54	S	HOME
0147NE 9 KNOX	09309179	GEORGE BAILY	/ /19 / /	-- --	-- --	-- --	-- - --		35-54-14 83-46-40	S	00580
0147NE 9 SEVIER	15500464	FREEMAN J	05/12/1966 / /	165 151	25 68	86 STEEL	-- - --	GOOD	35-52-56 83-47-05	S	00152 HOME
0147NE 9 SEVIER	15500516	REED M	06/21/1966 / /	206 180	5 105	16 STEEL	-- - --	GOOD	35-52-44 83-46-26	S	00152 MUN
0147NE 9 SEVIER	15500827	GREEN W	08/20/1968 / /	185 165	7 110	48 STEEL	-- - --	GOOD	35-52-53 83-46-55	S	00152 HOME
0147NE 9 SEVIER	15500830	NORRIS C	08/01/1968 / /	128 90	10 60	23 --	-- - --	GOOD	35-52-52 83-46-52	S	00078
0147NE 9 SEVIER	15500839	GAYLOR M	06/08/1968 / /	111 102	14 75	22 STEEL	-- - --	UNK	35-52-37 83-46-02	S	00078
0147NE 9 SEVIER	15500867	GALLOW L	05/03/1968 / /	160 140	-- 80	70 STEEL	-- - --	GOOD	35-52-56 83-46-57	S	00154 HOME

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS ON THE SHOOKS-GAP QUADRANGLE (0147NE) TN.

QUAD / NTH COUNTY	WELL NUM REG NUM	OWNER'S NAME LOCATION ROAD	COMP. DATE INSPT DATE	TOT DEPTH AQ DEPTH	TOT YIELD STAT LEVEL	CSE DEPTH CSE TYPE	WELL FINISH INTERVAL	WAT QUAL TAG NUM	LATITUDE LONGITUDE	A/C LOG USE	DRILLER LOG USE
0147NE 9 SEVIER	15500881	DODGEN O	04/06/1968 / /	214 --	--	20 STEEL	-- - --	GOOD	35-52-39 83-46-10	S	00365 HOME
0147NE 9 SEVIER	15505685	MCCROSKEY STEV PINE RIDGE	08/03/1989 / /	310 270	10 200	155 STEEL	OPEN 155 - 310	OTHR	- - - -	Y	00152 HOME
0147NE 9 SEVIER	15508239	ROY ATCHLEY	09/07/1972 / /	-- --	10 --	--	-- - --	GOOD	35-53-05 83-46-21	S	
0147NE 9 SEVIER	15508240	JOE PITNER	09/07/1972 / /	-- --	45 --	--	-- - --	GOOD	35-53-30 83-45-27	S	
0147NE 9 SEVIER	90000504	GODSEY ROY NEWELL CIRCLE R	01/26/1989 / /	460 216	12 6	118 STEEL	OPEN 118 - 460	OTHR	- - - -	Y	00158 HEAT
0147NE 9 SEVIER	90001604	WOLF RICH BOYDE CREEK RD	05/31/1990 / /	410 90	6 7	62 STEEL	OPEN -- - --	GOOD	- - - -	Y	00031 HOME
0147NE 9 SEVIER	91000369	GIBSON SAM	12/12/1990 / /	105 80	10 20	41 STEEL	OPEN 41 - 105	UNK	- - - -	Y	00264 HOME
0147NE 9 SEVIER	91001986	FOX JIMM ICKING	05/13/1991 / /	425 250	7 140	42 STEEL	OPEN 42 - 425	OTHR	- - - -	Y	00152 HOME
0147NE 9 KNOX	91002287	GARRETT EDDI SHADY	03/09/1991 / /	225 200	30 40	104 STEEL	OPEN 104 - 225	UNK	- - - -	Y	00536 HOME
0147NE 9 KNOX	92003426	ALLEN EP LOT 14 RAY GAP	09/18/1992 / /	310 210	10 45	42 OTHER	OPEN 42 - 310	OTHR	- - - -	Y	00589 HOME
0147NE 9 SEVIER	93004731	WALKER JR CLAR 1230 LITTLE BEA	03/02/1992 / /	540 175	15 --	163 STEEL	OPEN 163 - 540	GOOD	- - - -	Y	00385 HOME
0147NE 9 KNOX	94005107 D0008233	BROWN HARO DODSON OFF SWAP	11/15/1994 / /	205 160	15 80	77 STEEL	OPEN 77 - 205	UNK	- - - -	Y	00536 HOME
0147NE 9 KNOX	94005108 D0008231	MAPLES HERM RHEA	11/21/1994 / /	750 400	2 30	20 STEEL	OPEN 20 - 750	UNK	- - - -	Y	00536 HOME
0147NE 9 KNOX	94005117 D0008232	CONARD DAVI RHEA	11/17/1994 / /	155 110	10 30	20 STEEL	OPEN 20 - 155	UNK	- - - -	Y	00536 HOME

NOV 1987

TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION - DIVISION OF WATER SUPPLY
RECORDS OF WATER WELLS IN SELECTED AREAS OF TENNESSEE

EXPLANATION OF COLUMN HEADINGS

QUAD/NTH = Designation by number, Quadrant and ninth of the 2.5 - minute quadrangle area in which the well is located. The leading numbers identify the 15-minute quadrangle, the next two letters identify the 7.5-minute quadrant and the last digit identifies the one-ninth subdivision of the latter.

COUNTY = County in which the well is located.

WELL NUM = Identification number assigned to the well by the State.

TAG NUM = An inspection number assigned to the well at the time of inspection by the State.

OWNER'S NAME = Name of person or organization for whom the well was drilled.

LOCATION ROAD = Name of street or road from which to access the well. Blank if unknown.

COMP DATE = Month, day and year the well was completed.

INSPT DATE = Month, day and year the well was inspected by TDHE. Blank if well has not been inspected.

TOT DEPTH = Total depth of the well in feet.

AQ DEPTH = Depth, in feet, below land surface to the top of the shallowest aquifer or water-bearing zone tapped by the well.

TOT YIELD = Total yield of the well in gallons per minute (gpm). Yields less than one-half gpm reported as zero.

STAT LEVEL = Static water-level: depth, in feet, from the land surface to the surface of the water standing in an idle well.

CSE DEPTH = Casing depth: depth, in feet, to the bottom of the water tight casing installed in the well.

CSE TYPE = Casing type: PLAST = Plastic; STEEL = Steel; OTHER = any other material such as concrete, fiberglass or tile.

WELL FINISH = Construction of the well in the interval supplying water to the well: OPEN = Uncased or open hole; SLOT = Hand perforated or slotted pipe; SCREEN = Manufactured device designed to maintain the wall of the borehole and allow ground water to enter the well.

INTERVAL = The depth, in feet, from the top to the bottom of the interval that is open to the well.

WAT QUAL = Water Quality: a word to describe the relative quality of the well water such as GOOD, FAIR, BAD, LIME, IRON, SULFUR, SALT, OIL, GAS, OTHER.

GEO FORM = Name of the geologic formation tapped by the well (not generally reported).

LATITUDE = Latitude of well site in degrees, minutes, and seconds.

LONGITUDE = Longitude of well site in degrees, minutes, and seconds.

A/C = Accuracy Code for latitude and longitude: S = Nearest second; F = nearest 15 seconds; T = nearest 30 seconds; M = nearest minute; Blank = nearest 2.5 minutes.

LOG = Refers to availability of drillers log: Y = yes; N = no.

DRILLER = License number of driller who supervised construction of the well. Names provided upon request.

USE = Purpose for which the well was constructed: HOME = residential; COMM = commercial; etc.

" 1990 US Census Data "

USBC 1990. United States Bureau of the Census. 1990 US Census Data.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

Date: Tue, 9 Dec 1997 08:18:32 -0500 (EST)
From: burl h maupin <bhm@korrnet.org>
To: bhm@korrnet.org
Subject: 881673579

(no URL reload available)

1990 US Census Data
Database: C90STF3A
Summary Level: State--County

Knox County: FIPS.STATE=47, FIPS.COUNTY90=093

PERSONS

Universe: Persons

Total.....335749

UNWEIGHTED SAMPLE COUNT OF PERSONS

Universe: Persons

Total.....44169

100-PERCENT COUNT OF PERSONS

Universe: Persons

Total.....335749

PERCENT OF PERSONS IN SAMPLE

Universe: Persons

Total.....13.2

FAMILIES

Universe: Families

Total.....91357

HOUSEHOLDS

Universe: Households

Total.....133584

URBAN AND RURAL

Universe: Persons

Urban:

 Inside urbanized area.....261024

 Outside urbanized area.....0

Rural:

 Farm.....1233

 Nonfarm.....73492

PERSONS IN HOUSEHOLD

Universe: Households

1 person.....36314

2 persons.....44773

3 persons.....24431

4 persons.....18937

5 persons.....6466

6 persons.....1934

7 or more persons.....729

HOUSEHOLD TYPE AND PRESENCE AND AGE OF CHILDREN

Universe: Households

Family households:

 Married-couple family:

 With own children under 18 years.....31759

 No own children under 18 years.....41353

 Other family:

 Male householder, no wife present:

 With own children under 18 years.....1427

 No own children under 18 years.....1786

 Female householder, no husband present:

 With own children under 18 years.....7608

 No own children under 18 years.....7424

Nonfamily households.....	42227
FAMILY TYPE AND PRESENCE AND AGE OF CHILDREN	
Universe: Families	
Married-couple family:	
With children 18 years and over.....	12968
No children 18 years and over.....	60144
Other family:	
Male householder, no wife present:	
With children 18 years and over.....	988
No children 18 years and over.....	2225
Female householder, no husband present:	
With children 18 years and over.....	6083
No children 18 years and over.....	8949
FAMILY TYPE AND AGE OF CHILDREN	
Universe: Own children under 18 years	
In married-couple family:	
Under 3 years.....	9847
3 and 4 years.....	6415
5 years.....	3090
6 to 11 years.....	18123
12 and 13 years.....	5639
14 years.....	2756
15 to 17 years.....	8590
In other family:	
Male householder, no wife present:	
Under 3 years.....	291
3 and 4 years.....	167
5 years.....	147
6 to 11 years.....	766
12 and 13 years.....	212
14 years.....	125
15 to 17 years.....	386
Female householder, no husband present:	
Under 3 years.....	1430
3 and 4 years.....	1170
5 years.....	731
6 to 11 years.....	4541
12 and 13 years.....	1445
14 years.....	772
15 to 17 years.....	2315
GROUP QUARTERS	
Universe: Persons in group quarters	
Institutionalized persons (00I-99I):	
Correctional institutions (20I-24I, 27I, 28I, 95I).....	760
Nursing homes (60I-67I).....	1904
Mental (Psychiatric) hospitals (45I-48I).....	472
Juvenile institutions (01I-05I, 10I-12I, 15I).....	41
Other institutions (00I, 06I-09I, 13I, 14I, 16I-19I, 25I, 26I, 29I-.....	97
Other persons in group quarters (00N-99N):	
College dormitories (87N).....	7800
Military quarters (96N-98N).....	0
Emergency shelters for homeless persons (82N, 83N).....	394
Visible in street locations (84N, 85N).....	80
Other noninstitutional group quarters (00N-81N, 86N, 88N-95N, 99N).....	779
SCHOOL ENROLLMENT AND TYPE OF SCHOOL	
Universe: Persons 3 years and over	
Enrolled in preprimary school:	
Public school.....	3193
Private school.....	2139
Enrolled in elementary or high school:	
Public school.....	46610
Private school.....	3255
Enrolled in college:	
Public school.....	28712

Private school.....	2997
Not enrolled in school.....	235993
SCHOOL ENROLLMENT, EDUCATIONAL ATTAINMENT, AND EMPLOYMENT STATUS	
Universe: Persons 16 to 19 years	
In Armed Forces:	
Enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Not enrolled in school:	
High school graduate.....	22
Not high school graduate.....	0
Civilian:	
Enrolled in school:	
Employed.....	6185
Unemployed.....	1069
Not in labor force.....	9654
Not enrolled in school:	
High school graduate:	
Employed.....	1497
Unemployed.....	174
Not in labor force.....	330
Not high school graduate:	
Employed.....	873
Unemployed.....	322
Not in labor force.....	1037

INDUSTRY

Universe: Employed persons 16 years and over	
Agriculture, forestry, and fisheries (000-039).....	1965
Mining (040-059).....	379
Construction (060-099).....	10133
Manufacturing, nondurable goods (100-229).....	13259
Manufacturing, durable goods (230-399).....	10632
Transportation (400-439).....	6743
Communications and other public utilities (440-499).....	6395
Wholesale trade (500-579).....	8806
Retail trade (580-699).....	32470
Finance, insurance, and real estate (700-720).....	8452
Business and repair services (721-760).....	7943
Personal services (761-799).....	5014
Entertainment and recreation services (800-811).....	1843
Professional and related services (812-899):	
Health services (812-840).....	15164
Educational services (842-860).....	16041
Other professional and related services (841, 861-899).....	12817
Public administration (900-939).....	5530

SOURCE OF WATER

Universe: Housing units	
Public system or private company.....	137069
Individual well:	
Drilled.....	5345
Dug.....	681
Some other source.....	487

SEWAGE DISPOSAL

Universe: Housing units	
Public sewer.....	107538
Septic tank or cesspool.....	35435
Other means.....	609

PLUMBING FACILITIES

Universe: Housing units	
Complete plumbing facilities.....	142756
Lacking complete plumbing facilities.....	826
PLUMBING FACILITIES	
Universe: Vacant housing units	
Complete plumbing facilities.....	9759

Date: Tue, 9 Dec 1997 11:07:51 -0500 (EST)
From: burl h maupin <bhm@korrnet.org>
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(no URL reload available)

1990 US Census Data
Database: C90STF3C1
Summary Level: Metropolitan Statistical Area

Knoxville, TN MSA: MSACMSA=3840, GEOCOMP=00

PERSONS

Universe: Persons

Total.....604816

UNWEIGHTED SAMPLE COUNT OF PERSONS

Universe: Persons

Total.....87819

100-PERCENT COUNT OF PERSONS

Universe: Persons

Total.....604816

PERCENT OF PERSONS IN SAMPLE

Universe: Persons

Total.....14.5

FAMILIES

Universe: Families

Total.....170513

HOUSEHOLDS

Universe: Households

Total.....237614

URBAN AND RURAL

Universe: Persons

Urban:

Inside urbanized area.....303421

Outside urbanized area.....62220

Rural:

Farm.....8134

Nonfarm.....231041

PERSONS IN HOUSEHOLD

Universe: Households

1 person.....59012

2 persons.....81500

3 persons.....45433

4 persons.....34975

5 persons.....11973

6 persons.....3465

7 or more persons.....1256

HOUSEHOLD TYPE AND PRESENCE AND AGE OF CHILDREN

Universe: Households

Family households:

Married-couple family:

With own children under 18 years.....60402

No own children under 18 years.....79460

Other family:

Male householder, no wife present:

With own children under 18 years.....2539

No own children under 18 years.....3315

Female householder, no husband present:

With own children under 18 years.....12416

No own children under 18 years.....12381

Nonfamily households	67101
FAMILY TYPE AND PRESENCE AND AGE OF CHILDREN	
Universe: Families	
Married-couple family:	
With children 18 years and over	24794
No children 18 years and over	115068
Other family:	
Male householder, no wife present:	
With children 18 years and over	1935
No children 18 years and over	3919
Female householder, no husband present:	
With children 18 years and over	10352
No children 18 years and over	14445
FAMILY TYPE AND AGE OF CHILDREN	
Universe: Own children under 18 years	
In married-couple family:	
Under 3 years	17266
3 and 4 years	11705
5 years	5694
6 to 11 years	34542
12 and 13 years	11189
14 years	5667
15 to 17 years	16972
In other family:	
Male householder, no wife present:	
Under 3 years	484
3 and 4 years	307
5 years	222
6 to 11 years	1232
12 and 13 years	388
14 years	260
15 to 17 years	800
Female householder, no husband present:	
Under 3 years	2201
3 and 4 years	1997
5 years	1191
6 to 11 years	7296
12 and 13 years	2446
14 years	1190
15 to 17 years	3712
GROUP QUARTERS	
Universe: Persons in group quarters	
Institutionalized persons (00I-99I):	
Correctional institutions (20I-24I, 27I, 28I, 95I)	1212
Nursing homes (60I-67I)	3903
Mental (Psychiatric) hospitals (45I-48I)	648
Juvenile institutions (01I-05I, 10I-12I, 15I)	220
Other institutions (00I, 06I-09I, 13I, 14I, 16I-19I, 25I, 26I, 29I)	165
Other persons in group quarters (00N-99N):	
College dormitories (87N)	19321
Military quarters (96N-98N)	0
Emergency shelters for homeless persons (82N, 83N)	399
Visible in street locations (84N, 85N)	80
Other noninstitutional group quarters (00N-81N, 86N, 88N-95N, 99N)	1056
SCHOOL ENROLLMENT AND TYPE OF SCHOOL	
Universe: Persons 3 years and over	
Enrolled in preprimary school:	
Public school	5577
Private school	2903
Enrolled in elementary or high school:	
Public school	89754
Private school	4299
Enrolled in college:	
Public school	37255

Private school.....	6303
Not enrolled in school.....	436345
RACE BY SCHOOL ENROLLMENT, EDUCATIONAL ATTAINMENT,	
AND EMPLOYMENT STATUS	
Universe: Persons 16 to 19 years	
White:	
In Armed Forces:	
Enrolled in school:	
High school graduate.....	7
Not high school graduate.....	0
Not enrolled in school:	
High school graduate.....	32
Not high school graduate.....	0
Civilian:	
Enrolled in school:	
Employed.....	9654
Unemployed.....	1600
Not in labor force.....	14789
Not enrolled in school:	
High school graduate:	
Employed.....	2901
Unemployed.....	374
Not in labor force.....	499
Not high school graduate:	
Employed.....	1579
Unemployed.....	713
Not in labor force.....	1503
Black:	
In Armed Forces:	
Enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Not enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Civilian:	
Enrolled in school:	
Employed.....	462
Unemployed.....	247
Not in labor force.....	1560
Not enrolled in school:	
High school graduate:	
Employed.....	79
Unemployed.....	24
Not in labor force.....	132
Not high school graduate:	
Employed.....	66
Unemployed.....	23
Not in labor force.....	317
American Indian, Eskimo, or Aleut:	
In Armed Forces:	
Enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Not enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Civilian:	
Enrolled in school:	
Employed.....	48
Unemployed.....	0
Not in labor force.....	5
Not enrolled in school:	
High school graduate.....	

Employed.....	18
Unemployed.....	0
Not in labor force.....	0
Not high school graduate:	
Employed.....	3
Unemployed.....	13
Not in labor force.....	6
Asian or Pacific Islander:	
In Armed Forces:	
Enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Not enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Civilian:	
Enrolled in school:	
Employed.....	55
Unemployed.....	0
Not in labor force.....	217
Not enrolled in school:	
High school graduate:	
Employed.....	7
Unemployed.....	0
Not in labor force.....	0
Not high school graduate:	
Employed.....	11
Unemployed.....	0
Not in labor force.....	14
Other race:	
In Armed Forces:	
Enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Not enrolled in school:	
High school graduate.....	0
Not high school graduate.....	0
Civilian:	
Enrolled in school:	
Employed.....	8
Unemployed.....	10
Not in labor force.....	27
Not enrolled in school:	
High school graduate:	
Employed.....	12
Unemployed.....	2
Not in labor force.....	0
Not high school graduate:	
Employed.....	8
Unemployed.....	0
Not in labor force.....	0
INDUSTRY	
Universe: Employed persons 16 years and over	
Agriculture, forestry, and fisheries (000-039)	4815
Mining (040-059)	1352
Construction (060-099)	20388
Manufacturing, nondurable goods (100-229)	24260
Manufacturing, durable goods (230-399)	27362
Transportation (400-439)	11415
Communications and other public utilities (440-499)	9544
Wholesale trade (500-579)	12804
Retail trade (580-699)	55714
Finance, insurance, and real estate (700-720)	13597
Business and repair services (721-760)	12959

Personal services (761-799).....	9718
Entertainment and recreation services (800-811).....	3501
Professional and related services (812-899):	
Health services (812-840).....	24227
Educational services (842-860).....	24577
Other professional and related services (841, 861-899).....	19557
Public administration (900-939).....	10175
SOURCE OF WATER	
Universe: Housing units	
Public system or private company.....	218777
Individual well:	
Drilled.....	34242
Dug.....	4073
Some other source.....	3878
SEWAGE DISPOSAL	
Universe: Housing units	
Public sewer.....	151844
Septic tank or cesspool.....	105646
Other means.....	3480
PLUMBING FACILITIES	
Universe: Housing units	
Complete plumbing facilities.....	257175
Lacking complete plumbing facilities.....	3795
PLUMBING FACILITIES	
Universe: Vacant housing units	
Complete plumbing facilities.....	22101
Lacking complete plumbing facilities.....	1047
RACE OF HOUSEHOLDER BY PLUMBING FACILITIES	
Universe: Occupied housing units	
White:	

Mental (Psychiatric) hospitals (45I-48I)	2849
Juvenile institutions (01I-05I, 10I-12I, 15I)	2194
Other institutions (00I, 06I-09I, 13I, 14I, 16I-19I, 25I, 26I, 29)	3819
Other persons in group quarters (00N-99N):	
College dormitories (87N)	43683
Military quarters (96N-98N)	11126
Emergency shelters for homeless (82N, 83N)	1864
Visible in street locations (84N, 85N)	357
Other noninstitutional group quarters (00N-81N, 86N, 88N-95N, 99N)	6710

HOUSING UNITS

Universe: Housing units	
Total	2026067

URBAN AND RURAL

Universe: Housing units	
Urban:	
Inside urbanized area	0
Outside urbanized area	0
Rural	0
Not defined for this file	2026067

PERSONS IN UNIT

Universe: Occupied housing units	
1 person	442129
2 persons	610548
3 persons	359963
4 persons	283892
5 persons	105680
6 persons	32738
7 or more persons	18775

PERSONS PER OCCUPIED HOUSING UNIT

Universe: Occupied housing units	
Persons per occupied housing unit	2.56

" Soil Survey / Knox County Tennessee "

U.S.D.A./S.C.S. 1955. Soil Survey / Knox County Tennessee, (with map). U.S. Department of Agriculture/Soil Conservation Service. August. pages: 4-9, 12-27, 102-5, 116-19, 136-7, 198-203, 220-23, 226-7, 230-1, 234-5, 238-9, and Soil Map - Knoxville Quadrangle (Figure 6 - Soil Map).

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

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KNOX COUNTY, in the Valley of East Tennessee, is on predominantly rolling and hilly relief but has some steep and rugged areas. Corn and hay are the most important crops. General farming, based on dairying and supplemented by a cash crop of tobacco, is common in the more productive sections. Truck farming is also prevalent. Knoxville, centrally located in the county, is an important industrial and trading center and provides part-time employment for many rural inhabitants and also markets for farm produce. To provide a basis for the best agricultural uses for the land, this cooperative soil survey was made by the United States Department of Agriculture, the Tennessee Agricultural Experiment Station, and the Tennessee Valley Authority. Field work for this survey was completed in 1942. Unless otherwise specifically mentioned, statements in this report refer to conditions in the county at the time field work was completed.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Knox County is in the central part of East Tennessee (fig. 1). The total area of the county is approximately 329,600 acres, or 515 square miles.

ORGANIZATION AND POPULATION

Knox County was organized in 1792. Blount County was established from a part of Knox County in 1795; a small part of Grainger County was added to Knox in 1927, and a small part of Sevier County in 1933. At the time Knox County was established, the few white inhabitants lived chiefly in forts along Beaver Creek. Most of the early white settlers were from Virginia, North Carolina, and the northeast-

ern part of Tennessee. Many soldiers of the Revolutionary War took up claims in payment for their services. The first home in the area now occupied by Knoxville was built in 1786 (6).²

In 1950 there were 148,166 urban and 74,841 rural people in Knox County. Knoxville is the only incorporated urban area. With its adjoining communities, it includes practically all the urban population of the county. Mascot is the largest village not included in this urban area. Most of the present inhabitants of the county are of English, Scotch, and Irish descent.

Rural population is fairly well distributed over the county. The most sparsely populated rural sections are House Mountain, McAnnally Ridge, Chestnut Ridge, and Copper Ridge. The most densely populated are near Knoxville. More than half of the rural inhabitants do not depend entirely upon farming for a living. Many are employed in Knoxville and nearby industrial plants; some are employed in lumbering and marble quarrying, and a few by the county on public works.

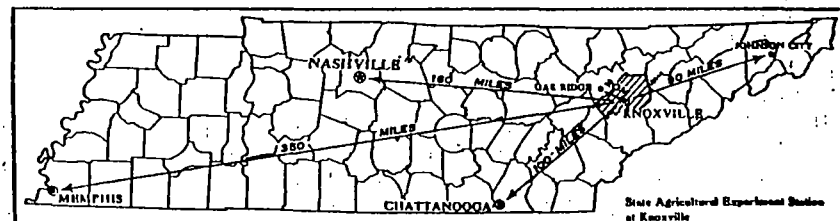


FIGURE 1.—Location of Knox County in Tennessee.

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

Knox County lies wholly within the Ridge and Valley, or Great Valley, physiographic province (5) of the southeastern United States. Locally this southern extremity of the province is known as the Valley of East Tennessee. The rock exposures are of the Cambrian, Ordovician, and Silurian geologic systems and are chiefly dolomitic limestones, limestones, and shales. The rock formations have been severely folded and faulted. Differential weathering and subsequent geologic erosion have caused ridges to form on the more resistant rocks, and valleys on the less resistant ones. As a consequence the dominant ridges and valleys follow the strike of the rock formations exposed. The result is a system of parallel ridges and valleys, the axes of which extend in a northeast-southwest direction. Most of the more rugged ridges are on interbedded sandstone and shale and calcareous sandstone; the more extensive valleys are on soft shale and argillaceous limestone. Much of the landscape over cherty dolomitic limestone is very nearly as high as the rugged shale ridges but the areas are broader and less sharply broken.

² Italic numbers in parentheses refer to Literature cited, p. 240.

³ For a more detailed description of the physiography of the county and its relation to the soils, see the section on Soil Associations.

The lay of the land is prevailingly rolling and hilly, but some areas on the ridges underlain by the more resistant rock are steep and rather rugged. Elevations above sea level range from 740 feet, at the surface of Clinch River where it leaves the county, to 2,128 feet, at the highest point on House Mountain. The difference in elevation between the valleys and ridges ranges approximately from 180 to 400 feet, except for House Mountain, which rises approximately 900 feet above the adjacent upland. Approximate elevations in feet above sea level of points that represent the general relief are: French Broad River, where it enters the county, 842; Fort Loudoun Reservoir, 813; the crest of Bays Mountains, a rugged ridge along the Knox-Sevier County line, 1,350 to 1,500; Tarklin Valley, to the northwest of Bays Mountains, 960 to 1,100; the crest of Blackoak Ridge, a ridge underlain by dolomitic limestone, 1,260 to 1,360; Hinds Valley, a valley over shale northwest of and adjacent to Blackoak Ridge, 1,020 to 1,160; and Beaver Ridge, adjacent to and northwest of Hinds Valley, 1,300 to 1,400.

The total area of alluvium is not great, considering the size of the streams that flow through the county. The larger alluvial plains are along the Tennessee, French Broad, Holston, and Clinch Rivers. The first bottoms, or flood plains, lie as narrow strips along the channels. Most of the bottoms are 300 to 800 feet wide; a few are about one-half mile wide. The stream terraces or benches are 15 feet to about 140 feet above the adjacent first bottoms. These terraces lie in irregular, discontinuous areas in the vicinity of the large streams. Few are as much as one-half mile wide.

The older, higher lying areas of terraces represent remnants of very old alluvial plains. Subsequent erosion has developed a rolling to hilly surface, and the alluvium ranges from scattered cobblestones on sedentary material to a layer 20 or 30 feet thick. The alluvium along the French Broad and Tennessee Rivers is a mixture of materials originating from shales, limestones, sandstones, and metamorphosed micaceous rocks. Along the other streams it is the same except for the lack of materials from micaceous rocks.

The drainage system is well developed. The larger streams flowing in the valleys form the main stems of a trellis system. In many places, streams flow through gaps in the ridges. In those parts of the county overlying dolomitic limestone, a karstlike topography prevails. Here a great many of the small drains lead to sinkholes, where the runoff water enters subterranean channels. Part of the runoff water, however, proceeds through a partially formed dendritic surface system to permanent surface streams in the shale valleys. Poorly drained areas are confined to small tracts along some of the drainageways and first bottoms and on floors of some of the sinkholes.

The French Broad and Holston Rivers, draining the eastern part of the county, converge about 4 miles east of Knoxville to form the Tennessee River. The northwest third of the county drains to the Clinch River, which joins the Tennessee River in the vicinity of Kingston in Roane County.

CLIMATE

The climate of Knox County is of the modified continental type. According to the classification of weather by Koppen (15), it has a warm and temperate climate with no distinct dry season but with hot summers in which the temperature of the warmest month averages 76.7° F. Long hot or cold periods are not common. Seasonal changes are usually gradual. The nearby mountains apparently have a moderating effect on weather in the Valley of East Tennessee. The United States Weather Bureau summary states: "The high mountains on the southeast act as a barrier to divert the hot southerly winds which occur when the pressure is high off the South Atlantic Coast, with the result that the maximum temperatures experienced in this valley are lower than those beyond the mountains in any direction. On the other hand, the Cumberland Plateau on the northwest retards and weakens the force of cold waves." The mountains also break the force of winds, as tornadoes are almost unknown in the valley and average wind velocity is low.

The generally mild and open winters allow outdoor farm work throughout the year. Many plants retain their green leaves through the winter. Native flowers bloom during most months of the year. Winter vegetables, winter grains, and perennials rarely suffer damage from cold. The average date of the last killing frost in spring is April 1, and that of the first in fall is October 28. The ground is seldom frozen to a depth of more than 2 inches and rarely remains frozen for more than a few hours. The alternate freezing and thawing tends to loosen the surface soil, however, and to render it especially susceptible to erosion. Winter crops are sometimes damaged by heaving. Moderate climatic conditions favor the raising of livestock and poultry, but fruits are often killed by freezes that follow warm spells in early spring.

The hills and the narrow intervening valleys of the county are favorable for nocturnal radiation. Almost without exception, cool and comfortable nights follow high temperatures during the day. The weather is seldom too severe for the enjoyment of outdoor recreation such as golf, hiking, and fishing.

The more important climatic data for the county, compiled from the records of the United States Weather Bureau Station at Knoxville, are given in table 1.

TABLE 1.—Normal monthly, seasonal, and annual temperature and precipitation at Knoxville, Knox County, Tenn.

[Elevation, 974 feet]

Month	Temperature ¹			Precipitation ²			
	Average	Absolute maximum	Absolute minimum	Average	Total for the driest year	Total for the wettest year	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December	39.1	75	-5	4.52	2.30	7.21	2.1
January	38.6	74	-16	4.66	2.19	6.92	2.7
February	40.8	79	-10	4.51	3.78	10.18	2.4
Winter	39.5	79	-16	13.69	8.27	24.31	7.2
March	47.5	88	5	5.05	4.41	13.07	1.4
April	57.3	93	23	4.14	1.39	5.86	2
May	66.7	95	34	3.75	4.21	1.23	(³)
Spring	57.2	95	5	12.94	10.01	20.16	1.0
June	73.8	99	42	4.10	2.60	4.06	0
July	76.7	104	52	4.36	1.86	7.64	0
August	75.4	101	50	3.92	2.03	5.60	0
Summer	75.3	104	42	12.38	6.49	18.20	0
September	69.4	102	35	2.68	4.56	4.14	0
October	58.5	94	24	2.62	1.44	2.81	(³)
November	46.5	80	8	3.07	2.90	4.25	.3
Fall	58.1	102	8	8.37	8.90	11.20	.3
Year	57.5	104	-16	47.38	33.67	73.87	9.1

¹ Average temperature based on 78-year record, 1870 to 1947; highest and lowest temperatures from 61-year record, 1870 to 1930.

² Average precipitation based on 79-year record, 1870 to 1948; wettest and driest years based on 81-year record, 1870 to 1950; snowfall on 48-year record, 1883 to 1930.

³ Trace.

⁴ In 1930.

⁵ In 1875.

VEGETATION

According to the classification of natural vegetation by Shantz and Zon (11), this county is in the chestnut-chestnut oak-yellow poplar belt of the Eastern forest region. The original vegetation was predominantly hardwoods and mixed hardwoods and pines. Chestnut, chestnut oak, white, red, and post oaks, hickory, ash, elm, maple, gum, beech, holly, white poplar, yellow-poplar, and yellow pine were the dominant species. Approximately 92,500 acres are now forested (12). Second-growth oak, hickory, dogwood, and shortleaf pine predominate in the present forest cover. Smaller proportions of yellow-pine, beech, maple, and *Liquidambar* in places. Little walnut

remains, and all the chestnut trees were killed by a blight before about 1930.

Most of the cleared land in farms is used for crops and pasture, although there is a notable acreage idle. On idle land and poorly managed pastures, the vegetation consists largely of wild grasses, broomsedge and other weeds, blackberry, persimmon, and sassafras. Volunteer stands of shortleaf pine are well established on many abandoned areas. A few areas have been planted to shortleaf and loblolly pine, and some to black locust and black walnut.

WATER SUPPLY

This county has a varied and, in most sections, abundant supply of water for livestock and household use. The rivers that drain the county supply some farms with stock water. Several large creeks and their permanent tributaries supply running water to a relatively large number of farms. Most of the creeks are moderately swift and clear except during flood periods. During the winter, spring, and early summer, enough water is available in practically all parts of the county. Late in summer and early in fall many small streams are dry and in some areas shallow wells are not reliable.

In the valleys of the cherty ridges of the Fullerton-Bolton-Clarks-ville soil association, larger streams generally flow continuously; but permanent springs are not numerous, and many dug and bored wells commonly fail in exceptionally dry periods. Consequently, many farms in this section depend either partially or entirely on cisterns and artificial ponds for water. Permanent springs and streams, natural ponds, and reliable bored wells are common in the limestone valleys (Decatur-Dewey-Emory and Stony land-Talbott soil associations). Dug and bored wells in the shale valleys (Jefferson-Monte-vallo, Sequoia-Leadvale, and Sequoia-Litz-Dandridge soil associations) are widely used and dependable. A few springs and permanent streams are in these areas also. An abundant supply of water is available from streams, wells, and springs on the first bottoms along the rivers and creeks. Water is commonly available either from the streams or wells in the valley parts of the Dandridge-Litz-Leadvale and Tellico-Neubert soil associations.

Fort Loudoun Lake is the reservoir for the water impounded by Fort Loudoun Dam, on the Tennessee River about 30 miles downstream from Knoxville. The dam is one of a series built by the Tennessee Valley Authority on the Tennessee River and its tributaries for flood control, navigation, and the generation of electricity. The lake covers about 13 square miles, with a total shoreline of about 343 miles. It extends about 35 miles upstream to the confluence of the Holston and the French Broad Rivers. There are a few other small ponds or lakes in the county. Some are natural lakes in sinkholes and a few were formed by damming small streams.

Fort Loudoun Reservoir and some of the smaller bodies of water provide facilities for boating, fishing, and swimming.

WILDLIFE

Game animals and birds are limited in numbers. Squirrel

bedrock, the extent of erosion, or artificial drainage, for example, are characteristics that might cause a surveyor to divide a soil type into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture, especially of the surface layer, may differ. As long as the other characteristics of the soil layers are similar, these soils are considered to belong in the same soil series. A soil series therefore consists of all soil types, whether the number be only one or several, that are, except for texture—particularly the texture of the surface layer—about the same in kind, thickness, and arrangement of layers.

The name of a place near where a soil series was first found is chosen as the name of the series; thus, Colbert is the name of a soil series found in Colbert County, Alabama. Two types of the Colbert series are found in Knox County, Tenn.—Colbert silty clay loam and Colbert silty clay. Each of these soil types has a distinct surface soil texture, as its name indicates.

When very small areas of two or more kinds of soil are so intricately mixed they cannot be shown separately on a map of the scale used, they are mapped together, and the areas of the mixture are called a soil complex. Muskingum-Lehew fine sandy loams is a complex of Muskingum fine sandy loam and Lehew fine sandy loam in Knox County.

Gullied land, limestone rockland, and stony land that have little agricultural value or little true soil are known as miscellaneous land types and are not designated with series and type names but are given descriptive names, as Gullied land (Armuchee and Litz soil materials), Limestone rockland (rolling and hilly) and Stony very steep land (Muskingum soil material).

The soil type or, where the soil type is subdivided, the soil phase, is the mapping unit in soil surveys. It is the unit, or the kind of soil, that is most nearly uniform and has the narrowest range of characteristics. For this reason land-use and soil-management practices can be more definitely specified for it than for broader groups of soils that include more variation.

THE SOILS OF KNOX COUNTY, THEIR USE AND MANAGEMENT

GENERAL NATURE OF THE SOILS

Soils on uplands occupy about 76 percent of the county; those on alluvial foot slopes and along drains, 14 percent; those on stream terraces, 3 percent; and those on first bottoms, 7 percent.

The upland soils have formed over high-grade limestone, cherty limestone, clayey or argillaceous limestone, calcareous shale, interbedded shale and limestone, calcareous sandstone, acid shale, or interbedded shale and sandstone. Soils on uplands have greater range in characteristics and in use suitability and management requirements than those of the other groups. Most of the steep and all of the shallow soils are of this group, as well as some of the smoothest and

areas of more than 50 acres, except along the foot of the steep shaly ridges. In great part, the soils of this group are suited to crops; practically all of them not suited to crops are suited to pasture. These soils require more exacting management than those on first bottoms, as they are lower in fertility, more susceptible to erosion, and more difficult to work and maintain.

The soils on stream terraces and those on first bottoms are chiefly along the Holston, French Broad, Clinch, and Tennessee Rivers and Bullrun Creek. Much of the acreage of these soils is well suited to crops and a great part is used for this purpose. The areas on first bottoms are subject to flooding, although those along the four rivers have been largely freed of this hazard by dams upstream designed to retain floodwaters.

About 20 percent of the county has a steep surface, with slopes of more than 25 percent; 25 percent has a hilly surface, with slopes from 12 to 25 percent. In great part, these steep and hilly soils are on uplands, and a large acreage is shallow to bedrock. On the whole these soils are not well suited to cultivation, and in large part the steep shallow areas are suitable only to forest. Approximately 30 percent of the county has a rolling surface ranging from 5 to 12 percent; 17 percent has an undulating surface ranging from 2 to 5 percent; and 8 percent is nearly level. Soils of these three slope groups are predominantly fair to excellent for crops, although stoniness, compactness, and shallow depth to bedrock make a notable acreage poorly suited to this use. Practically all the soils of the first bottoms are nearly level. Most of those on stream terraces, on foot slopes, and along drains are undulating and rolling. Soils on the uplands range from undulating to steep.

The surface or plow layers of a great part of the soils have textures ranging from loam to silty clay loam. Silt loams and silty clay loams predominate in the soils developed over limestone; loams and clay loams in the Tellico-Neubert soil association; and fine sandy loams and clay loams in the Muskingum-Lehew soil association. Many of the soils on colluvium adjacent to the Muskingum-Lehew association have loam or fine sandy loam surface layers. A notable part of the acreage on the broader first bottoms has a loam or fine sandy loam texture. A very small amount of loamy fine sand is included with Staser fine sandy loam. The severely eroded Colbert soil, as well as some of the severely eroded Talbott soil, has a silty clay or clay plow layer. Practically all of the silty clay loam and clay loam soils are former areas of silt loams and loams, respectively, that have lost through erosion either all or a considerable part of their original surface layers.

Various degrees of stoniness are common over much of the county. About 50 percent of the soil area is stone-free or at least not stony enough to materially interfere with tillage. Almost all the soils on first bottoms are stone-free, and much of the acreage on stream terraces and in the Decatur-Dewey-Emory, the Fullerton-Bolton-Clarks-ville, the Tellico-Neubert, and the Sequoia-Leadvale soil associations are practically stone-free. About 39 percent of the county is occupied by soil sufficiently stony to interfere materially with but not to prevent

land, Waynesboro, and Nolichucky soils) have cobblestones that interfere materially with tillage. Almost 11 percent of the county is so stony that tillage is impractical. Stoniness makes areas of the Stony land-Talbott and the Muskingum-Lehew soil associations unfit even for grazing. Less extensive areas too stony for practical cultivation are in the Sequoia-Leadvale, the Sequoia-Litz-Dandridge, the Dandridge-Litz-Leadvale, the Tellico-Neubert, the Sequoia-Bland-Leadvale, and the Bland-Camp soil associations.

Depth to bedrock ranges from practically nothing to more than 20 feet. Soils having depths of more than 5 feet occupy about 57 percent of the county. A great part of the soils on first bottoms, stream terraces, and practically all of the Decatur, Dewey, Fullerton, and Clarksville soils are well over 5 feet deep. In places soils on foot slopes and along drains have bedrock within less than 5 feet of the surface, but a large part has greater depth. Soils having depths ranging from about 18 inches to 5 feet make up almost 14 percent of the county. The Sequoia and Talbott and a notable proportion of the soils on foot slopes and along drains are of this thickness. The rest of the county is occupied mainly by soils having an average depth to bedrock of less than 20 inches; chief among these are the Dandridge, Litz, Montevallo, Armuchee, Bland, Muskingum, and Lehew soils. The stony land types have an average depth to bedrock of less than 18 inches; the limestone-rockland miscellaneous land types have bedrock at the surface over a great part of their area.

On a large acreage of the soils permeability is favorable for the crops commonly grown. The Huntington, Congaree, Staser, Etowah, Neubert, Alcoa, Emory, Abernathy, and Greendale soils have the most favorable moisture relations. The capacity to hold moisture available to crops is somewhat restricted in many of the other soils deep to bedrock and is notably limited in those soils shallow to bedrock.

About 15 percent of the acreage of the county is high in natural fertility; 47 percent moderate, and 38 percent rather low. The most fertile soils are the Huntington, Lindsie, Congaree, Chewacla, Emory, Abernathy, Ooltowah, Neubert, Alcoa, Etowah, Cumberland, Decatur, Dewey, and Farragut. A great part of their acreage is in the Cumberland-Huntington and the Decatur-Dewey-Emory soil associations (pl. 2, A and B). The associations consisting predominantly of soils of low fertility are the Muskingum-Lehew, the Montevallo, and the Jefferson-Montevallo.

In the agriculture commonly practiced, about 51 percent of the county acreage is suited to crops that require tillage (First-, Second-, and Third-class soils). About 25 percent is not suited to crops but suitable for pasture (Fourth-class soils). Approximately 24 percent is poorly suited to either crops or pasture (Fifth-class soils). The 51 percent suited to crops requiring tillage is divided as follows: 6 percent, very well suited (First-class soils); 28 percent, well suited (Second-class soils); and 17 percent, fairly well suited (Third-class soils).

First- and Second-class soils predominate in the Cumberland-Huntington, the Staser-Hamblen, and the Decatur-Dewey-Emory soil associations; Second-, Third-, and Fourth-class soils in the Fullerton-Bolton-Clarksville and the Sequoia-Leadvale; Fourth-class soils in the Armuchee-Leadvale, the Dandridge-Litz-Leadvale, and the Stony

The soil series of Knox County are grouped in table 2 according to their position on the landscape, and some of their distinguishing characteristics are given. Of the five soil series on uplands common to the limestone valleys, the Decatur and Dewey are the most important. They are recognized by their red subsoils, generally great depth to bedrock, and relatively high natural fertility. They are among the most desirable soils for the production of crops and pasture. The Talbott, Colbert, and Bland soils are more clayey and have a heavier consistence than the Decatur and Dewey soils. They are notably shallower to bedrock and have a lower fertility. The Talbott soils are distinguished from the Colbert in having a red rather than yellow clay subsoil and average a little deeper to bedrock. The Bland soils are distinguished by their dusky-red color. They are not limited to limestone valley positions, as a large part of their acreage is on steep rugged ridges, so strongly sloping and shallow to bedrock in many places as to be poorly suited to cultivation.

The Fullerton, Clarksville, and Bolton soils are on gravelly or cherty ridges and, like the Decatur and Dewey soils, are interassociated in many places. In general, however, the Clarksville soils are more common along the northwestern parts of the cherty ridge belts. On the whole, the Fullerton acreage predominates on these ridges, whereas the Bolton soils are limited to areas of 5 to 40 acres, which are numerous and widely distributed. All of these soils are deep to bedrock limestone, most of which is dolomitic. The Fullerton soils are distinguished by their reddish-yellow subsoil, and the Clarksville by their yellow subsoil. The Bolton soils are distinguished by their decidedly brown surface soil, those of the Clarksville and Fullerton being comparatively gray. The Clarksville soils are notably low in fertility, the Fullerton are moderate, and the Bolton approach the higher fertility of the Dewey.

The Farragut, Montevallo, much of the Sequoia, and some of the Litz and Dandridge soils occupy the upland parts of the shale valleys. The Farragut soils have surface layers and sublayers to a depth of 18 or 20 inches similar to those of the Decatur. They differ in that they have shale at a depth of 1½ to 4 feet, whereas the Decatur soils are underlain by limestone at a greater depth. The Sequoia soils have lighter colored surface soils and subsoils than the Farragut and are less fertile, although under good management they are productive. The Litz, Dandridge, and Montevallo soils are very shallow to shale, and the surface layer commonly has at least a moderate amount intermixed. All are of low fertility, but of the three, the Dandridge is the most productive.

The Dandridge, Litz, and Armuchee soils of the shale hills are all shallow to bedrock and have hilly to steep slopes. The Dandridge and Litz areas are so intricately intermixed that they are mapped together. The Dandridge soils are shallow to calcareous (limy) shale bedrock, whereas the Litz soils rest on leached (soft) shale to depths ranging from 4 to 8 feet, under which there is generally calcareous shale. The Armuchee soils are underlain by interbedded limestone and shale. Soils of all three series, though not well suited to cultivation, are moderately productive of the common pasture grasses and legumes.

TABLE 2.—*Distinguishing characteristics of soil series in Knox County, Tenn.*

SOILS ON UPLANDS

Topographic position and soil series	Parent rock or parent material	Description	Dominant relief
Limestone valleys:			
Decatur.....	High grade limestone.....	Dark-brown surface soil; brownish-red silty clay subsoil.	Undulating to hilly.
Dewey.....	do.....	Grayish-brown surface soil; yellowish-red silty clay subsoil.	Undulating to steep.
Talbott.....	Clayey (argillaceous) limestone.....	Grayish-brown surface soil; red plastic clay subsoil.	Undulating to hilly.
Colbert.....	do.....	Brownish-gray surface soil; yellow very plastic clay subsoil.	Do.
Bland.....	Dusky-red ¹ shaly limestone.....	Dusky-red surface soil; dusky-red silty clay subsoil.	Rolling to hilly.
Steep purplish limestone ridges:			
Bland.....	do ¹	do.....	Hilly to steep.
Cherty ridges (gravelly or cherty ridge lands):			
Fullerton.....	Moderately cherty limestone.....	Brownish-gray surface soil; reddish-yellow moderately cherty silty clay subsoil.	Undulating to steep.
Clarksville.....	Very cherty limestone.....	Gray surface soil; brownish-yellow very cherty silty clay subsoil.	Rolling to steep.
Bolton.....	Sandy limestone or limestone with thin sandy layers.	Dark-brown surface soil; reddish-brown silty clay loam to silty clay subsoil.	Do.
Shale valleys:			
Sequoia.....	Interbedded shale and limestone or calcareous (limy) shale.	Brownish-gray surface soil; reddish-yellow silty clay subsoil.	Undulating to hilly.
Farragut.....	High grade limestone over acid shale.	Brown surface soil; reddish-brown silty clay subsoil.	Do.
Montevallo.....	Acid shale.....	Yellowish-gray surface soil; brownish-yellow very shaly silty clay loam subsoil.	Undulating to steep.
Litz.....	Leached shale or shale interbedded with some limestone.	Yellowish-gray surface soil; brownish-yellow shaly silty clay loam subsoil.	Hilly to steep.

Shale hills:			
Dandridge.....	Calcareous (limy) shale (blue slate land).	Grayish-yellow surface soil; brownish-yellow shaly silty clay loam subsoil.	Do.
Litz.....	Leached shale.....	Yellowish-gray surface soil; brownish-yellow shaly silty clay loam subsoil.	Do.
Armuchee.....	Interbedded limestone and shale.....	Brownish-gray surface soil; yellowish-red and yellow silty clay subsoil.	Do.
Steep sandy and shaly ridges:			
Lehew.....	Dusky-red sandy shale.....	Weak-red surface soil; weak- to dusky-red friable clay loam subsoil.	Do.
Muskingum.....	Sandstone or interbedded sandstone and shale.	Brownish-gray surface soil; light-yellow stony sandy loam or loam subsoil.	Do.
Red sandy ridges:			
Tellico.....	Calcareous sandstone.....	Light reddish-brown surface soil; dark-red sandy clay subsoil.	Rolling to steep.

SOILS ON FOOT SLOPES AND ALONG DRAINS

Drainheads and drainage-ways in limestone valleys:	Colluvium and local alluvium chiefly from—		
Enory.....	Decatur, Dewey, and Farragut soils.	Brown surface soil; light reddish-yellow to yellowish-brown silty clay loam subsoil.	Undulating to rolling.
Drainheads and drainage-ways in cherty ridges:			
Greendale.....	Fullerton and Clarksville soils.	Brownish-gray surface soil; light brownish-yellow to yellowish-brown silty clay loam subsoil.	Do.
Sinkholes in limestone valleys and on cherty ridges:			
Abernathy.....	Decatur, Dewey, and Farragut soils.	Brown or reddish-brown surface soil; reddish or yellowish-brown silt loam subsoil.	Nearly level.
Ooltewah.....	Decatur, Dewey, Farragut, Fullerton, and Clarksville soils.	Grayish-brown to brown surface soil; yellowish-brown mottled below 18 to 24 inches.	Do.
Guthrie.....	Fullerton, Talbott, Colbert, and Sequoia soils.	Gray surface soil; gray, mottled with yellow and brown, clay subsoil.	Do.

¹ Commonly called purplish-red or Indian red.

TABLE 2.—Distinguishing characteristics of soil series in Knox County, Tenn.—Continued

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SOILS ON FOOT SLOPES AND ALONG DRAINS

Topographic position and soil series	Parent rock or parent material	Description	Dominant relief
Drainageways and foot slopes below steep dusky-red limestone: Camp-----	Bland soils-----	Weak-red to dusky-red surface soil; dusky-red silty clay loam subsoil.	Gently sloping to sloping.
Relatively high foot slopes below steep sandy shaly ridges: Jefferson-----	Muskingum and Lehigh soils-----	Grayish-yellow surface soil; brownish-yellow clay loam subsoil.	Undulating to rolling.
Drainheads and drainageways below steep sandy and shaly ridges: Cotaco-----	Muskingum, Lehigh, and Jefferson soils.	Yellowish-gray surface soil; mottled yellow, gray, and brown clay loam subsoil.	Do.
Drainheads and drainageways in shale valleys and hills: Leadvale-----	Dandridge, Armuchee, Sequoia, Litz, Montevallo, Muskingum, and Lehigh soils.	Gray surface soil; yellow grading to mottled silty clay loam subsoil.	Do.
Whitesburg-----	Dandridge, Armuchee, Litz, and Sequoia soils.	Brownish-gray surface soil; yellow grading to mottled silt loam or silty clay loam subsoil.	Do.
Relatively high foot slopes below red sandy ridges: Alcoa-----	Tellico soils-----	Brown surface soil; yellowish-red silty clay loam subsoil.	Do.

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Drainheads and drainageways below red sandy hills: Neubert-----	do-----	Reddish-brown surface soil; brownish-red clay loam subsoil.	Do.
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SOILS ON STREAM TERRACES

High stream terraces: Cumberland-----	Mixed alluvium strongly influenced by limestone.	Brown surface soil; red silty clay subsoil-----	Undulating to hilly.
Waynesboro-----	Mixed alluvium from shale, sandstone, and limestone.	Grayish-brown surface soil; red sandy clay subsoil.	Do.
Nolichucky-----	do-----	Gray surface soil; reddish-yellow sandy clay subsoil.	Rolling.
Moderately high stream terraces: Etowah-----	Mixed alluvium strongly influenced by limestone.	Grayish-brown surface soil; yellowish-brown, with a reddish cast, silty clay loam subsoil.	Undulating to hilly.
Tyler-----	Mixed alluvium from shale, sandstone, and limestone.	Light-gray surface soil; mottled gray and yellow clay subsoil.	Nearly level.
Low stream terraces: Wolftever-----	Mixed alluvium from limestone, shale, and sandstone.	Light-brown surface soil; light yellowish-brown compact silty clay subsoil.	Undulating to rolling.
Sequatchie-----	Predominantly sandy alluvium-----	Grayish-brown surface soil; brownish-yellow sandy clay loam subsoil.	Do.

SOILS ON FIRST BOTTOMS

Huntington-----	Mixed alluvium apparently strongly influenced by limestone.	Brown surface soil; brown or yellowish-brown subsoil.	Nearly level.
Lindside-----	do-----	Brown surface soil; mottled silty clay loam subsoil.	Do.

KNOX COUNTY, TENNESSEE

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TABLE 2.—Distinguishing characteristics of soil series in Knox County, Tenn.—Continued

SOILS ON FIRST BOTTOMS—Continued

ographic position and soil series	Parent rock or parent material	Description	Dominant relief
in	Mixed alluvium apparently strongly influenced by limestone.	Brownish-gray surface soil; mottled gray and yellow silty clay subsoil.	Nearly level.
ie	Alluvium from Clarksville and Fullerton soils.	Grayish-brown cherty surface soil; yellowish-brown or yellowish-gray cherty compact silty clay loam subsoil.	Do.
ir	Mixed alluvium derived chiefly from shale, much of which was calcareous or limy.	Grayish-brown surface soil; yellowish-brown fine sandy loam to silt loam subsoil.	Nearly level to very gently undulating.
iblen	do.	Light yellowish-brown surface soil; mottled gray, brown, and yellow silty clay loam subsoil.	Nearly level.
ier	do.	Light-gray surface soil; light-gray somewhat mottled clay subsoil.	Do.
igaree	Mixed alluvium, much of which was derived from micaceous rocks.	Brown surface soil and subsoil with much mica throughout.	Nearly level to very gently undulating.
ivacka	do.	Brown surface soil; mottled gray, yellow, and brown subsoil.	Nearly level.

The Lebew and Muskingum soils, like the Dandridge, Litz, and Armuchee, are shallow to bedrock and have hilly to steep slopes. Their parent rocks, however, are acid or low in lime, and the soils are much less productive of pasture or crops than the Dandridge, Litz, and Armuchee. Soils of the Lebew and Muskingum series occur intermixed on the steep sandy shale ridges, such as Sharp and Beaver Ridges. Muskingum soils occupy all of House Mountain.

The Tellico soils are dusky-red sandy soils on the steep rugged ridges, such as Brown Mountain southeast of Knoxville. The range in depth to bedrock is greater than for the shale-hill soils, and the smoother parts, though limited in extent, are well suited to cultivation. The color of the Tellico soils somewhat resembles that of the Decatur, but the subsoil is much more friable and permeable and the natural fertility is lower.

Of the soils occurring on foot slopes and along drains, those on local alluvium and colluvium—the Emory, Greendale, Camp, Abernathy, Ooltewah, and Guthrie—consist of material derived chiefly from limestone. The Abernathy, Ooltewah, and Guthrie occupy sinkholes and differ from each other chiefly in degree of drainage. The Abernathy has the best drainage, and the Guthrie the poorest.

Emory soils are associated chiefly with Decatur, Dewey, and Faragut soils and usually lie on gentle foot slopes around sinkholes occupied by Abernathy soils. The Abernathy and Emory soils are among the most productive in the county and are suited to a wide variety of crops, although crops on the Abernathy are damaged at times by temporary flooding.

The Greendale soils, like the Emory, occupy foot slopes but consist of the somewhat less fertile local alluvium washed from the Fullerton and Clarksville soils. They are more yellowish than the Emory soils. The Camp series includes the dusky-red soils on foot slopes of local alluvium associated with the Bland soils. Though rather high in clay, they are well suited to crops and are productive of most crops commonly grown.

Jefferson and Cotaco soils consist of local alluvium and colluvium from the Muskingum and Lebew. The Jefferson soils are older than the Cotaco, occupy the more rolling higher foot slopes adjacent to Muskingum and Lebew ridges, and are well drained. In contrast, the Cotaco soils consist of young more gently sloping alluvium along the drainageways leading out from these ridges and have slow internal drainage as indicated by their mottled subsoil. In large part, Cotaco and Jefferson soils are suited to crops, but their natural fertility is much lower than that of the Emory soils.

The Leadvale and Whitesburg soils consist of local alluvium and colluvium from shale areas. The Leadvale occupies the higher, older, more sloping areas, and the Whitesburg the narrow strips of young alluvium along the drainageways. They occupy the local alluvial areas throughout the shale ridges and valleys and were mapped together as phases of Leadvale and Whitesburg silt loams. The Whitesburg soils are distinguished by their slightly acid to slightly alkaline reaction, as compared with the more acid reaction of the Cotaco, Jefferson, and Leadvale series.

Neubert soils lie as gently sloping strips at drain heads and along the upper reaches of the drainageways. Both soils are friable and permeable and have better internal drainage than the Leadvale, Cotaco, and Whitesburg soils. They are productive and among the most desirable soils for crops.

The Cumberland and Etowah are well-drained silty soils on the older stream terraces. They are classified with those soils of the stream terraces that consist predominantly of limestone material or have been strongly influenced by it. The Cumberland approximate the Dewey soils in color. In places they are as brown in the surface soil and as red in the subsoil as the Decatur soils. The Etowah soils are somewhat less brown in the surface soil and less reddish in the subsoil and are more friable than the Cumberland. In general they occupy somewhat lower positions, the Cumberland occupying chiefly the highest stream terraces. Both of these soils are fertile and much of their acreage is good cropland.

Like the Cumberland and Etowah, the Waynesboro and Nolichucky soils are well drained. They differ chiefly in being noticeably more sandy and are classed as a mixed general alluvium to which sandstones or other sand-bearing rocks have made a large contribution. Both occupy high stream terraces comparable to those on which Cumberland soils occur. The Waynesboro has a browner surface soil and a redder subsoil and is more fertile than the Nolichucky. Much of their aggregate area is suited to crops.

The Tyler soil represents the poorly or very poorly drained soils on stream terraces. It is associated with soils of the lower terraces; very little or no acreage is associated with the Cumberland, Waynesboro, and Nolichucky of the high stream terraces. It also includes the very poorly drained areas on local alluvium in the shale valleys, where it is associated with Leadvale and Whitesburg soils. The Tyler soil is poorly suited to most crops that require tillage.

Wolflever and Sequatchie soils occupy low stream terraces and are mostly located along the Holston, French Broad, Clinch, and Tennessee Rivers. Wolflever soils are moderately fertile but have a rather compact subsoil; their internal drainage in most places is somewhat impaired, and the soil may be subject to occasional flooding. Sequatchie soils are sandy and permeable. Wolflever and Sequatchie soils are well suited to crops requiring tillage.

The Huntington, Roane, Staser, and Congaree are well-drained soils on first bottoms along the Tennessee River, which carries micaceous sediments from the Blue Ridge physiographic province. The Congaree is distinguished by its high content of mica, as it consists chiefly of alluvium originating from schist, gneiss, and granite. The Chewacla is an imperfectly drained soil associated with the Congaree.

The Huntington soils, located mainly along the Holston River, are distinguished by their rich-brown color and friable silt loam texture. Their parent alluvium is thought to consist largely of material originating from limestone, although considerable amounts of shale and sandstone are intermixed.

Lindside and Melvin soils are the imperfectly and poorly drained soils, respectively, that are associated with the Huntington. They occupy a large part of the first bottoms along creeks that drain wholly or in part from soils over limestone. Very little alluvium along these creeks is sufficiently well drained to be classified as Huntington soil.

The Huntington and Lindside soils are among the most fertile soils of the county.

The Roane soils border creeks carrying sediments from the more extensive areas of Fullerton and Clarksville soils. They are moderately well drained, contain more chert, and are lower in fertility than the Huntington soils. In places, the cherty substratum is partly cemented.

The Staser, Hamblen, and Prader soils consist chiefly of alluvium of shale and mixed shale and sandstone origin that is slightly acid to slightly alkaline. Much of this alluvium originated from calcareous shales or interbedded shale and limestone. The Staser soils are well drained and are lighter brown and average lower in fertility than the Huntington. The Hamblen soils are imperfectly drained and the Prader soils are poorly drained.

SOIL TYPES AND PHASES

In this section the various soils of the county are described in detail and their relation to agriculture—including present use and management, use suitability, and management requirements—are set forth as far as present knowledge permits. The acreage and proportionate extent of each soil are given in table 3, and its location and distribution are represented on the detailed soil map that accompanies this report.

TABLE 3.—Acreage and proportionate extent of the soils mapped in Knox County, Tenn.

Soil	Acre	Percent
Alcoa silt loam:		
Eroded rolling phase		
Eroded undulating phase	193	0.1
Armuchee silt loam, steep phase	334	.1
Armuchee silty clay loam:	2,261	.7
Eroded hilly phase		
Eroded steep phase	415	.1
Bland silt loam:	754	.2
Rolling phase		
Steep phase	139	(1)
Bland silty clay loam:	1,115	.3
Eroded hilly phase		
Eroded rolling phase	581	.2
Eroded steep phase	559	.2
Bolton silt loam:	682	.2
Eroded hilly phase		
Eroded rolling phase	1,227	.4
Eroded steep phase	2,356	.7
Bolton silty clay loam:	528	.2
Severely eroded hilly phase		
Severely eroded rolling phase	1,186	.4
Severely eroded steep phase	244	.1
Camp silt loam	851	.3
Chewacla silt loam	210	.1
Clarksville cherty silt loam:	271	.1
Eroded hilly phase		
Eroded rolling phase	2,420	.7
Eroded steep phase	3,120	.9
Hilly phase	1,118	.3
Rolling phase	2,900	.9
Steep phase	2,864	.9
	7,733	2.3

See footnote at end of table.

TABLE 3.—Acreage and proportionate extent of the soils mapped in
Knox County, Tenn.—Continued

Soil	Acres	Percent
Colbert silty clay:		
Severely eroded hilly phase	282	.1
Severely eroded rolling phase	512	.1
Colbert silty clay loam:		
Eroded rolling phase	464	.1
Eroded undulating phase	108	.1
Congaree fine sandy loam:		
Low-bottom phase	390	.1
Congaree silt loam:		
Low-bottom phase	447	.1
Congaree silt loam:		
Low-bottom phase	783	.2
Low-bottom phase	92	(¹)
Cumberland gravelly fine sandy loam, eroded rolling phase	299	.1
Cumberland silty clay loam:		
Eroded hilly phase	439	.1
Eroded rolling phase	978	.3
Eroded undulating phase	205	.1
Severely eroded hilly phase	269	.1
Severely eroded rolling phase	124	(¹)
Dandridge and Litz shaly silt loams:		
Eroded hilly phases	9,797	3.0
Eroded steep phases	2,834	.9
Dandridge and Litz silt loams:		
Hilly phases	1,224	.4
Steep phases	2,352	.7
Dandridge shaly silt loam:		
Eroded hilly phase	934	.3
Eroded steep phase	812	.2
Dandridge silt loam, steep phase	576	.2
Decatur silt loam:		
Rolling phase	130	(¹)
Undulating phase	377	.1
Decatur silty clay loam:		
Eroded hilly phase	305	.1
Eroded rolling phase	2,606	.8
Eroded undulating phase	1,556	.5
Severely eroded hilly phase	636	.2
Severely eroded rolling phase	328	.1
Dewey silt loam:		
Rolling phase	153	(¹)
Undulating phase	227	.1
Dewey silty clay loam:		
Eroded hilly phase	953	.3
Eroded rolling phase	5,504	1.7
Eroded steep phase	180	(¹)
Eroded undulating phase	1,257	.4
Severely eroded hilly phase	1,831	.6
Severely eroded rolling phase	959	.3
Emory and Abernathy silt loams	1,165	.4
Emory silt loam:		
Rolling phase	1,207	.4
Undulating phase	9,076	2.8
Etowah silt loam, undulating phase	208	.1
Etowah silty clay loam:		
Eroded hilly phase	179	(¹)
Eroded rolling phase	1,086	.3
Eroded undulating phase	907	.3
Severely eroded hilly phase	238	.1
Farragut silty clay loam:		
Eroded hilly phase	167	(¹)
Eroded rolling phase	658	.2
Eroded undulating phase	421	.1

TABLE 3.—Acreage and proportionate extent of the soils mapped in
Knox County, Tenn.—Continued

Soil	Acres	Percent
Fullerton cherty silt loam:		
Eroded hilly phase	4,506	1.4
Eroded rolling phase	6,813	2.1
Eroded steep phase	3,853	1.2
Hilly phase	3,545	1.1
Rolling phase	2,143	.7
Steep phase	6,028	1.8
Fullerton cherty silty clay loam:		
Severely eroded hilly phase	2,484	.8
Severely eroded rolling phase	505	.1
Severely eroded steep phase	1,583	.5
Fullerton loam:		
Eroded hilly phase	1,062	.3
Eroded rolling phase	4,074	1.2
Eroded undulating phase	224	.1
Hilly phase	188	.1
Rolling phase	373	.1
Undulating phase	187	.1
Fullerton silt loam:		
Eroded hilly phase	5,406	1.6
Eroded rolling phase	11,774	3.6
Eroded undulating phase	1,014	.3
Hilly phase	1,091	.3
Rolling phase	1,208	.4
Undulating phase	327	.1
Fullerton silty clay loam:		
Severely eroded hilly phase	3,070	1.2
Severely eroded rolling phase	929	.3
Greendale cherty silt loam:		
Rolling phase	335	.1
Undulating phase	255	.1
Greendale silt loam:		
Rolling phase	1,568	.5
Undulating phase	8,451	2.6
Gullied land:		
Armuchee and Litz soil materials	8,435	2.6
Fullerton and Talbott soil materials	3,980	1.2
Sequoia and Montevallo soil materials	1,209	.4
Talbott and Decatur soil materials	492	.1
Tallico and Muskingum soil materials	2,182	.7
Guthrie silt loam	644	.2
Hamblen fine sandy loam	1,713	.5
Hamblen silt loam	1,190	.4
Huntington silt loam	779	.2
Low-bottom phase	130	(¹)
Jefferson and Montevallo clay loams severely eroded rolling phases	1,035	.3
Jefferson and Montevallo loams:		
Eroded rolling phases	1,963	.6
Eroded undulating phases	577	.2
Jefferson loam, eroded rolling phase	1,282	.4
Leadvale and Cotaco loams:		
Rolling phases	506	.1
Undulating phases	4,247	1.3
Leadvale and Whitesburg silt loams:		
Rolling phases	536	.2
Undulating phases	13,203	4.0
Limestone rockland:		
Rolling and hilly	2,776	.8
Steep	1,739	.5

See footnote at end of table.

TABLE 3.—Acreage and proportionate extent of the soils mapped in Knox County, Tenn.—Continued

Soil	Acres	Percent
Lindside silt loam.....	9,716	2.0
Made land.....	1,060	.3
McInt silt loam.....	2,733	.8
Montevallo shaly silt loam:		
Eroded hilly phase.....	1,225	.4
Eroded rolling phase.....	1,719	.5
Eroded steep phase.....	213	.1
Eroded undulating phase.....	482	.1
Montevallo silt loam, steep phase.....	136	(¹)
Muskingum-Lehew fine sandy loams:		
Eroded hilly phases.....	3,573	1.1
Eroded steep phases.....	2,286	.7
Hilly phases.....	373	.1
Steep phases.....	12,760	3.9
Muskingum stony fine sandy loam, steep phase.....	476	.1
Neubert loam:		
Rolling phase.....	859	.3
Undulating phase.....	895	.3
Nolichucky gravelly loam, eroded rolling phase.....	545	.2
Ooltewah silt loam.....	1,284	.4
Prader silt loam.....	626	.2
Roane silt loam.....	1,942	.6
Sequatchie fine sandy loam.....	618	.2
Sequoia-Bland silty clay loams:		
Eroded hilly phases.....	208	.1
Eroded rolling phases.....	1,641	.5
Eroded undulating phases.....	1,301	.4
Severely eroded hilly phases.....	756	.2
Severely eroded rolling phases.....	1,186	.4
Sequoia silt loam:		
Rolling phase.....	787	.2
Undulating phase.....	813	.2
Sequoia silty clay loam:		
Eroded rolling phase.....	9,701	2.0
Eroded undulating phase.....	7,018	2.4
Severely eroded rolling phase.....	7,112	2.2
Severely eroded undulating phase.....	453	.1
Staser fine sandy loam.....	275	.1
Low-bottom phase.....	140	(¹)
Staser silt loam.....	933	.3
Stony hilly and steep land, Colbert and Talbott soil materials.....	10,867	3.3
Stony rolling land, Colbert and Talbott soil materials.....	5,027	1.7
Stony very steep land, Muskingum soil material.....	807	.2
Talbott silty clay loam:		
Eroded rolling phase.....	1,007	.3
Eroded undulating phase.....	318	.1
Severely eroded hilly phase.....	384	.1
Severely eroded rolling phase.....	327	.1
Tellico clay loam:		
Severely eroded hilly phase.....	1,762	.5
Severely eroded rolling phase.....	641	.2
Severely eroded steep phase.....	2,559	.8
Tellico loam:		
Eroded hilly phase.....	2,088	.6
Eroded rolling phase.....	3,279	1.0
Eroded steep phase.....	1,543	.5
Hilly phase.....	644	.2
Rolling phase.....	276	.1
Steep phase.....	4,942	1.5

See footnote at end of table.

TABLE 3.—Acreage and proportionate extent of the soils mapped in Knox County, Tenn.—Continued

Soil	Acres	Percent
Tyler silt loam.....	176	(¹)
Waynesboro clay loam, severely eroded hilly phase.....	252	0.1
Waynesboro loam:		
Eroded hilly phase.....	460	.1
Eroded rolling phase.....	908	.3
Eroded undulating phase.....	217	.1
Wolfcreek silty clay loam:		
Eroded rolling phase.....	135	(¹)
Eroded undulating phase.....	382	.1
Total land area.....	329,600	100.0

¹ Less than 0.1 percent.

Alcoa silt loam, eroded undulating phase (2-5% slopes) (An).—This soil occurs on foot slopes in the general vicinity of higher lying steep and hilly areas of Tellico soils and is composed of colluvium or local alluvium washed from those soils. It is associated with Sequoia and Litz soils of the shale valleys. All of the areas are in the southeastern part of the county, roughly south and east of United States Highway No. 70. The soil has a brownish-red surface where cultivated or bare. A large part is so eroded that much of the plow layer consists of a mixture of original surface and subsoil material. Internal drainage is medium.⁴

Profile description:

0 to 5 inches, reddish-brown silt loam.

5 to 30 inches, yellowish-red firm but friable silty clay loam.

30 inches +, variegated brown, yellow and gray soft weathered shale with harder less weathered shale a few feet below.

The depth to the shaly material ranges from 3 to about 8 feet in most places. Where erosion has not been active, the surface layer is 7 to 12 inches of brown, mellow silt loam.

The reaction is medium to strongly acid, and the natural fertility is moderately high. The soil is easily permeable down to the underlying shale and has large capacity for holding moisture available to plants.

Use and management.—All of this soil has been cleared and much of it is now used for crops, including corn, tobacco, small grains, lespedeza, and alfalfa. Little is either idle or used for pasture. It is a First-class soil,⁵ although its productivity, workability, and conservability are a little lower than for a few other soils. It is well suited to a wide variety of crops, including truck crops and alfalfa. Moderately short rotations are suited, but care is required to avoid erosion. The more sloping parts will benefit from contour tillage and vigorous winter cover crops.

⁴ "Medium" denotes optimum internal drainage for the production of commonly grown crops.

⁵ See section on Use Suitability Groups for definitions of First-, Second-, Third-, Fourth-, and Fifth-class soils.

The soil is suited to truck crops and tobacco, but greater care is required to maintain productivity where these crops are grown. Legumes and grasses for hay and pasture are suited. If good stands of the more exacting legumes and grasses are to be maintained, however, relatively heavy fertilization must be practiced. Where good management is practiced, corn yields about 50 bushels, wheat about 22 bushels, and alfalfa about 2.9 tons an acre.

Greendale cherty silt loam, undulating phase (2-5% slopes) (Gb).—This very cherty soil consists of colluvium and local alluvium washed from soils (mainly Clarksville and Fullerton) underlain by cherty dolomitic limestone. It differs from the undulating phase of Greendale silt loam chiefly in having enough chert throughout its entire depth to interfere materially with tillage. In addition, this soil is less extensive and is not so widely distributed throughout the cherty ridge lands. It is more commonly associated with Clarksville than with Fullerton soils.

Profile description:

0 to 10 inches, gray or brownish-gray silt loam containing much coarse gritty material and chert fragments, some as much as 6 inches in diameter.
10 to 20 inches, gray to yellowish-gray silt loam or silty clay loam containing much gritty material and many chert fragments.
20 to 40 inches, light brownish-yellow or grayish-yellow silty clay loam mottled with light-brown or light shades of gray; contains variable amounts of grit and chert fragments.

Chert beds may be in the lower part of the soil, and dolomitic limestone bedrock is at widely variable depths ranging from 8 to 25 feet.

The natural fertility and organic-matter content are low and the reaction is medium to strongly acid. Internal drainage is medium to very rapid and the soil is easily permeable to both roots and moisture. The soil is moderate in capacity to hold moisture available to crops and is a little droughty where the content of chert is exceptionally high.

Use and management.—About three-fourths of this soil is cleared; the rest is under native deciduous forest, chiefly oaks. About 10 percent is used for crops. Corn and hay (mostly lespedeza, redtop, and orchard grass) are the chief crops. The rest of the cleared acreage is used for pasture. Little fertilization is practiced and little lime is applied. Under ordinary conditions corn yields about 22 bushels and lespedeza 1.0 ton or less an acre. Pastures are of relatively low quality; their carrying capacity does not exceed 75 cow-acre-days.

Chertiness, low fertility, and rather limited capacity for holding moisture available to plants restrict the usefulness of this soil for both tilled crops and pasture. The soil is low in productivity and rather difficult to work, but it is not particularly subject to loss of soil through runoff. Corn and hay are among the better suited crops; but if good yields are to be expected, heavy fertilization, adequate liming, and much organic matter are required.

Under a high level of management, corn should yield 45 bushels, lespedeza 1.7 tons, and tobacco 1,400 pounds an acre. The more desirable legumes and grasses can be maintained but good stands are more difficult to establish and hold than on many of the more fertile soils. Where adequate fertilization and liming, proper seeding, and control of weeds and brushy growth are practiced, pastures with a carrying capacity of about 105 cow-acre-days can be obtained.

Greendale cherty silt loam, rolling phase (6-12% slopes) (Ga).—This soil differs from the undulating phase chiefly in having a stronger slope. It consists of very cherty colluvium and local alluvium washed chiefly from the associated Clarksville soils. The natural fertility and content of organic matter are low.

Use and management.—About 70 percent of the acreage is cleared; the rest is under deciduous forest, chiefly oaks. About 10 percent is used for crops, mainly corn, lespedeza, redtop, and orchard grass. The rest is used for pasture. Little fertilization is practiced and yields are low. The natural pasture plants are mainly lespedeza and broomsedge, with other volunteer vegetation. Their carrying capacity is about 70 cow-acre-days.

The soil is low in productivity and rather difficult to work but is not very susceptible to erosion. The very cherty nature, low fertility, and rather limited supplies of moisture held for plants restrict the usefulness of this soil for both tilled crops and pasture. Corn and hay are probably among the better suited crops. If they are to produce good yields, heavy fertilization, adequate liming, and much organic matter will be required. Under a high level of management, corn should yield 40 bushels and lespedeza 1.5 tons an acre.

The narrower strips occurring along drains within steeper areas of Clarksville and Fullerton soils are not well situated for cropping but are suitable for pasture. The more desirable legumes and grasses for pasture can be grown, although good stands are more difficult to maintain than on the more fertile soils. The droughtiness of much of the acreage limits the growth of pasture during dry periods. Nevertheless, where the fertility is brought to a high level and a good pasture cover is developed, the carrying capacity is about 100 cow-acre-days.

Gullied land, Armuchee and Litz soil materials (12-50% slopes) ((Gc)).—This land type consists of areas of Armuchee, Litz, Dandridge, and Bland soils that have been reduced to a network of gullies by erosion. The areas range from a few acres to about 25 in size and are widely distributed throughout the Dandridge-Litz-Leadvale, the Sequoia-Litz-Dandridge, the Armuchee-Leadvale, and the Bland-Camp soil associations. The surface soil has been removed from most of the areas, and gullies of variable depth form an intricate pattern. The surface is too rough to allow the use of ordinary farm machinery and the prevailing relief is hilly or steep.

The exposed soil material in the Armuchee areas consists of yellowish-red firm silty clay. Much of the exposed material in the Dandridge areas is brownish-yellow friable shaly silty clay loam, and that in the Bland areas is weak-red firm silty clay. A few limestone ledges outcrop in the Armuchee and Bland areas, but the Dandridge and Litz areas are mostly free of hard rock outcrops; the bedrock being calcareous or soft weathered shale.

Use and management.—All this gullied land has been cleared and used for crops. Parts are now under volunteer pine forest or idle. An intermittent cover of sassafras, briars, and broomsedge is common to many of the idle areas but the cover on many parts is not sufficient to arrest erosion. A few areas may have an exceptionally good cover of kudzu, and here, as in the pine-covered areas, erosion is restrained and the soil is being slowly restored.

This land type is of little value except for forest. Shortleaf pine is well suited and can be expected to produce useful timber after growing 25 or 30 years. Kudzu is well suited to provide protection against erosion and is an economical means of rebuilding the areas for more desirable pasture plants. Some farmers may find it feasible to smooth these gullied areas and then establish fairly good pasture by heavy fertilization and careful seeding. This more rapid means of rebuilding the soil is more feasible in those areas that have milder slopes, shallow gullies, and no hard rock outcrops.

Gullied land, Fullerton and Talbott soil materials (12-50% slopes) (Gr).—This land type consists of hilly and steep areas of Fullerton, Clarksville, Talbott, Dewey, and Decatur soils that have been greatly mutilated by erosion. The surface soil has been removed from a great part of the area, and gullies of variable depth form an intricate pattern. The surface is too rough for cultivation with ordinary farm machinery and the general relief is hilly and steep.

The tracts are widely distributed, chiefly in the Fullerton-Bolton-Clarksville soil association. This gullied land is much less common than Gullied land (Armuchee and Litz soil materials). Furthermore, its separate areas (2 to 10 acres) are smaller and less numerous because most of the soils from which it is derived are less subject to erosion than the Dandridge, Armuchee, Litz, Bland, and Sequoia soils.

The exposed soil material consists mostly of brownish-yellow to reddish-yellow firm cherty silty clay. The few areas of Dewey, Decatur, and Talbott soil material consist chiefly of red or yellowish-red firm to plastic silty clay. Most areas, except those of Talbott soil material, are free of bedrock outcrops. Where limestone bedrock outcrops are common, the gullies range in depth from less than 2 feet to 10 or 12 feet, and on the average are somewhat deeper than those common to Gullied land, Armuchee and Litz soil materials.

Use and management.—All of the acreage of Gullied land, Fullerton and Talbott soil materials, has been cleared and used for crops at some time. A small part is now under volunteer pine forest. A great part is idle and covered by sassafras, briars, and broomsedge. This cover in most places is not adequate to restrain erosion effectively. A few areas have a good cover of kudzu. In these and the pine-covered areas erosion is thoroughly restrained and the soil is slowly rebuilding.

This land type is of little value except for forest. Shortleaf pine is well suited and can be expected to produce useful timber after growing 25 or 30 years. Kudzu affords grazing and is well suited to provide protection against erosion. It is an economical means of rebuilding the areas for more desirable pasture plants.

It may be practical to construct check dams to stop further development of ditches and gullies. In places, diversion ditches along the upper edges of the areas will be useful in reducing runoff water passing through the gullied areas. Some farmers may find it feasible to smooth the less severely gullied parts and to establish fairly good pasture by heavy fertilization and careful seeding.

Gullied land, Sequoia and Montevallo soil materials (4-12% slopes) (Go).—This gullied land consists of areas of Sequoia, Jefferson, and Montevallo soils that have been mutilated by erosion. The

separate areas are small but relatively numerous; most of them are in the Jefferson-Montevallo, the Montevallo, the Sequoia-Litz-Dandridge, and the Sequoia-Leadvale soil associations. Generally the surface soil has been removed from a great part of the areas and shallow gullies form an intricate pattern. The surface is too rough to be cultivated with ordinary farm machinery.

The exposed soil consists chiefly of brownish-yellow friable to firm shaly clay loam, although in many places it is predominantly variegated yellowish-brown and gray acid shale. There are few or no hard rock outcrops. Practically all of the surface soil has been removed; gullies are seldom more than 2 or 3 feet deep.

Use and management.—All of the acreage of this gullied land has been cleared and used for crops. Parts are now under volunteer pine forest but most of the land is idle and has an intermittent cover of sassafras, briars, and broomsedge that is not sufficient to stop erosion. In the few areas under kudzu or forested with pine, erosion is thoroughly restrained and the soil is being slowly restored.

This land type is of little value except for forest. Shortleaf pine is well suited and can be expected to produce useful timber after growing about 30 years. Kudzu affords some grazing and is effective against erosion. It provides an economical means of rebuilding the areas for more desirable pasture plants but growth will not be as luxuriant as on the more naturally fertile areas of Gullied land, Fullerton and Talbott soil materials; and Gullied land, Talbott and Decatur soil materials. It may be found feasible to construct check dams and diversion ditches. On some farms it may be practical to smooth off gullied areas with heavy tillage implements and establish fairly good pasture by heavy fertilization and careful seeding. In general, use of heavy tillage implements on this gullied land will be more feasible than on the more strongly sloping gullied lands because the gullies are generally shallow and runoff is not quite so active.

Gullied land, Talbott and Decatur soil materials (4-12% slopes) (Gn).—This gullied land consists of former areas of Talbott, Decatur, and Dewey soils. The surface soil has been removed from a great part, and intricate gullies of moderate depth have formed. The areas are not numerous but are widely distributed in parts of the Stony land-Talbott and the Decatur-Dewey-Emory soil associations, more commonly in the Stony land-Talbott. The surface is too rough for ordinary farm machinery; the general relief is rolling.

The exposed soil material consists chiefly of red or yellowish-red firm to plastic silty clay. Bedrock outcrops are not common in areas associated with the Dewey and Decatur soils but are common in those associated with the Talbott.

Use and management.—All of this gullied land has been cleared and used for crops. A small part is under pine forest; a great part is idle. The idle areas are partly covered by sassafras, briars, and broomsedge or are bare. The plant cover generally is not adequate to stop erosion. A few areas may have a good cover of kudzu, and here, as in the pine-covered areas, erosion is restrained and the soil is being slowly remade.

This land type is of little value except for forest. Shortleaf pine is well suited. Kudzu provides some pasture and is an effective cover as well as an economical means of rebuilding areas for the production of such more desirable plants as bluegrass and white clover. It may

grown or pasture established, organic matter will be of considerable value in producing high yields. The Cotaco soil can be improved by artificial drainage, especially for row crops. The feasibility of drainage will depend on a number of factors. Where management of this combination of soils is kept at a high level and drainage is adequate, corn should yield 52 bushels; lespedeza, 1.6 tons; and pasture, 140 cow-acre-days of grazing an acre.

Leadvale and Cotaco loams, rolling phases (7-16% slopes) (La).—This combination of soils differs from the undulating phases of Leadvale and Cotaco loams mainly in having stronger slopes. Some slopes reach gradients of 20 percent. The Leadvale soil occupies a larger proportion of this mapping unit than it does of undulating phases of Leadvale and Cotaco loams. Accordingly, the acreage is smaller in which drainage is notably impaired. The areas occur as narrow strips along drainageways in shale valleys in which Montevallo and Jefferson soils predominate.

Use and management.—Much of the area of these soils is cleared and used for hay, pasture, and corn. Lespedeza is the chief hay crop. Some pastures consist chiefly of lespedeza and others predominantly of broomsedge. Fertilization is practiced for corn, and lime has been applied to some areas.

These soils are suitable for tilled crops, but moderately low fertility, more rolling slopes, and somewhat impaired drainage limit the natural productivity and range of suitability. The stronger slopes require moderately long rotations if the soils are to be adequately conserved. The lime requirement is high, and additions of the usually deficient plant nutrients and organic matter are necessary if good yields are to be obtained. As with the undulating phases of Leadvale and Cotaco loams, the Cotaco soil areas have exceptionally good moisture relations for midsummer pastures. If adequately fertilized and seeded, the Cotaco areas have a carrying capacity of approximately 135-cow-acre-days. Under a high level of management these soils can be expected to yield 50 bushels of corn and 1.6 tons of lespedeza an acre.

Leadvale and Whitesburg silt loams, undulating phases (0-7% slopes) (Lo).—The soils of this combination lie as strips along drainageways in association with the soils developed from calcareous shale and interbedded acid shale and limestone. Their material was derived mainly from the Sequoia, Armuchee, Litz, and Dandridge series. These are among the more extensive of the soils developed on colluvium and are widely distributed throughout the Sequoia-Leadvale, Sequoia-Litz-Dandridge, Dandridge-Litz-Leadvale, and Armuchee-Leadvale soil associations.

The Whitesburg soil is derived from colluvium or local alluvium composed of materials originating chiefly in areas of calcareous shales. It predominates in areas immediately adjacent to the drainageways. There is no strong textural distinction between the surface and subsoil layers, and the reaction is less acid than that of the Leadvale soil. The surface 10 inches is brownish-gray silt loam. Below this and extending to about 18 inches is light-yellow silt loam or silty clay loam. Below 18 inches is mottled light-yellow and gray silty clay loam.

The Leadvale soil predominates in the higher areas more removed from the drainageways, although in places it is also directly adjacent. The surface 8 inches of the Leadvale soil ranges from grayish-yellow to gray silt loam. Below this and continuing to a depth of about 24 inches is yellow firm silty clay loam. The material below this depth is mottled yellow and gray firm but friable silty clay loam. Shale bedrock is at depths of 4 to 15 feet.

Internal drainage is slow, and during the wetter periods the water table is at or near the surface in areas adjacent to the drainageways. The soil material, however, is permeable to both roots and moisture. The natural fertility is moderate but the organic-matter content is rather low. The reaction ranges from moderately acid to slightly alkaline in the Whitesburg soil and from moderately to strongly acid in the Leadvale soil.

There are a few areas of this combination of soils that have good internal drainage, and here the surface soil is a little browner and the subsoil is free of mottlings to a depth of more than 30 inches. These areas can be expected to be somewhat more fertile and suited to a wider variety of crops than most of the others.

Use and management.—Most of this soil combination is cleared and used for hay and pasture. Some corn and small grains and a small amount of tobacco are grown. Lespedeza and redtop are the chief hay and pasture plants. Lime has been applied to much of the acreage. Corn and small grains receive moderate fertilization. Under ordinary conditions corn yields about 40 bushels and lespedeza about 1.1 tons an acre. Pasture has a carrying capacity of about 90 cow-acre-days.

These soils are well suited to many of the crops commonly grown. They are moderately productive, easily worked, and easily conserved. Their slow internal drainage, however, makes them poorly suited to such crops as alfalfa and restricts periods of cultivation. Where adequately fertilized and limed, they can be used intensively for row crops, as runoff is not an erosion hazard. Small grains and hay are among the best suited crops. Much of the acreage, especially of the Whitesburg soil, is desirable for pasture, since the moisture relations favor a long growing season. Relatively heavy fertilization and, on the Leadvale soil, adequate applications of lime, are necessary if relatively high yields are to be realized. Under good management corn will yield 55 bushels and lespedeza about 1.7 tons an acre. Where the fertility has been brought to a high level, the more desirable pasture plants such as orchard grass, bluegrass, white clover, and lespedeza provide about 145 cow-acre-days of grazing.

Leadvale and Whitesburg silt loams, rolling phases (8-12% slopes) (Lo).—These soils occur along drainageways in the Sequoia-Leadvale, Sequoia-Litz-Dandridge, Dandridge-Litz-Leadvale, and the Armuchee-Leadvale soil associations. They differ from the undulating phases of Leadvale and Whitesburg silt loams chiefly in having strong slopes. In general the proportion of Leadvale soil is greater in this combination of soils than in the undulating phases of Leadvale and Whitesburg silt loams. Internal drainage, though rather slow, is somewhat better than in the undulating phases. Only a small part of these rolling phases has a high water table during the wetter seasons.

Use and management.—Much of the acreage of these soils has been cleared and is used for small grains, hay, and pasture. A small amount is used for corn. Pasture and hay are not of high quality; they generally consist of lespedeza, broomsedge, and some redtop. Some areas have been limed, and some fertilization is practiced. The more remote areas—those in the hillier landscapes—do not receive much fertilization. Crop yields under ordinary conditions are not high.

These soils are well suited to many of the crops commonly grown; but chiefly because of the stronger slope, somewhat longer rotations are required and more care is necessary in controlling runoff than for the undulating phases of Leadvale and Whitesburg silt loams. Small grains and hay and pasture crops are best suited, although row crops such as corn and tobacco will produce well where the fertility and organic-matter content are maintained at high levels. Some areas may be suited to alfalfa, but those adjacent to the drains are generally too wet.

Limestone rockland, rolling and hilly (2-25% slopes) (Lr).—This land type occupies gently sloping to hilly areas where limestone outcrops and loose rock cover a great part of the surface. Most of it is in the Stony land-Talbott soil association. There is a small amount of soil material that resembles Talbott and Colbert soils in texture and consistence, but it occupies less than 25 percent of the surface and ranges from only a few inches to 12 inches thick over bedrock. This soil material is fertile but so shallow to bedrock and limited in extent that it is of no value for crops that require tillage and of little value for pasture. Most of it supports a scrubby growth of cedars, oaks, and underbrush.

Limestone rockland, steep (25+ % slopes) (Lr).—This land type differs from Limestone rockland, rolling and hilly, chiefly in having stronger slopes. The gradient ranges up to 60 percent. Much of it occurs as bluffs along larger streams and around quarries. In a few places the slopes are precipitous, or clifflike. A great part of the surface is occupied by limestone outcrops and loose rock. There is a small amount of soil material in the interstices. The vegetation is predominantly cedars and scrubby deciduous trees, chiefly oaks, with a variable amount of brushy growth intermixed. This land is valueless for crops, pasture, or even forest cover. Trees are small and grow slowly.

Lindside silt loam (0-2% slopes) (Lo).—This imperfectly drained soil on first bottoms is derived from mixed alluvium largely of limestone origin or strongly influenced by limestone. It is widely distributed over the county along a great many of the creeks (pl. 9, B) that flow through areas underlain by limestone or interbedded limestone and shale. Areas also occur along the Holston River. The surface is nearly level. Practically all areas are subject to flooding, although those along the Holston River are now partly protected by a flood-control dam upstream.

Profile description:

0 to 8 inches, brown or pale-brown silt loam.

8 to 20 inches, brown silt loam with some mottlings of gray and yellow.

20 inches+, mottled gray, yellow, and some brown heavy silt loam or silty clay loam; limestone or shale bedrock at widely variable depths—in places at less than 5 feet and in others as much as 35 or 40.

In places there is a dark-brown silt loam or silty clay loam layer at depths of 10 to 20 inches. It represents an older surface layer that has been buried by more recent floodwater deposits. A variable amount of chert occurs in a few places, but not enough to interfere materially with cultivation.

This is a fertile soil with a moderate content of organic matter. It ranges from moderately acid to slightly alkaline. Internal drainage fluctuates. The soil is sometimes flooded during the wettest season, but during the drier months the water table is about 3 feet below the surface. The soil is permeable to moisture and roots, although excessive moisture in the subsoil does not encourage root development of some of the deep-rooted plants. The high moisture-holding capacity for plants and the moderate depth to the water table during the drier seasons make this soil particularly favorable for midsummer pasture and for crops requiring abundant moisture late in summer and in fall.

Use and management.—A great part of this soil has been cleared. Some is used for permanent pasture, but a notable part is used for crops, chiefly corn and hay. On many areas corn is grown several years in succession. Little fertilization is practiced, since the occasional flooding aids greatly in maintaining relatively high fertility. Under ordinary conditions corn yields about 45 bushels an acre and pasture has a carrying capacity of about 115 cow-acre-days.

Lindside silt loam is suited to crops requiring tillage, but its range of suitability is limited by slow internal drainage and susceptibility to flooding. It is particularly well suited to permanent pasture, certain hay crops such as lespedeza, timothy, and redtop, and row crops such as corn and soybeans. It can be used intensively for row crops, as its natural fertility is high and runoff is no hazard.

Although this is a fertile soil, it will respond to proper fertilization, especially with phosphorus. In general, weed growth is rank on soils like this one, and adequate weed control will aid in obtaining high yields. Where additional acreage is needed for crops requiring better internal drainage, it may be feasible to improve some areas by artificial drainage.

Where high fertility and adequate drainage are maintained and weeds are eradicated, corn will yield 60 to 65 bushels and lespedeza about 2 tons an acre. Because of high fertility and particularly favorable moisture relations, this soil provides pasture of high quality over a long grazing season. The carrying capacity under good management, which particularly includes adequate fertilization and suppression of weedy and brushy growth, should be about 150 cow-acre-days.

Made land (0-15% slopes) (Ma).—This land type occupies areas that have been altered by man-made excavations or depositions and have no agricultural value. It includes fills, dumps, and such excavations as quarries and mines. Some of these areas are in railroad yards and a few are athletic fields. They are rather widely scattered over the county, but most of them are in the vicinity of Knoxville and Mascot. Those in the vicinity of Mascot consist chiefly of refuse from zinc mines.

Melvin silt loam (0-2% slopes) (Mb).—This very poorly drained soil on first bottoms was derived from mixed general alluvium. The parent rock for this alluvium apparently was predominantly limestone

Use and management.—Practically all of this soil is forested. It occupies areas that have never been cleared and cultivated and therefore has not been subjected to erosion. The soil is fairly well suited to cultivated crops. It is moderately productive and not particularly hard to work. The slow percolation and moderately strong slope are conducive to erosion, however, especially on tilled areas. Since it is susceptible to erosion, the soil needs long rotations that include close-growing small grains and grasses and legumes for hay and pasture. Where feasible, field work should be done on the contour. Subsoiling and strip cropping may also be practical ways of restricting erosion. Adequate applications of fertilizer, organic matter, and lime are required if yields are to be kept high. Under good management corn will yield 38 bushels and alfalfa about 2.8 tons an acre. Under favorable conditions the carrying capacity of well-established pasture will be about 100 cow-acre-days.

Sequoia silty clay loam, eroded rolling phase (5-12% slopes) (Sk).—This soil differs from Sequoia silt loam, undulating phase, chiefly in its stronger slope and its loss of a considerable part of the original surface soil through erosion. It is one of the most extensive of the Sequoia soils and occupies much of the Sequoia-Leadvale soil association (pl. 11, B). A considerable acreage is also in the Sequoia-Litz-Dandridge and the Dandridge-Litz-Leadvale associations. The separate areas range from 10 to 60 acres in size.

The plow layer consists of a mixture of the original surface soil with some subsoil material; ordinarily it is a brownish-yellow silty clay loam. In spots practically all the surface soil has been lost and the plow layer consists of reddish-yellow very firm silty clay. The surface is rolling but small smoother areas are included.

The natural fertility is medium, and the content of organic matter is low. The reaction is medium to strongly acid. Internal drainage is somewhat impaired to slow, and percolation of moisture is greatly retarded by the firm subsoil. Roots, however, can penetrate the soil material to shale bedrock.

Use and management.—All of this soil has been cleared and used for crops at some time but a small part is now idle. Corn, small grains, and lespedeza hay are the chief crops. Small acreages of alfalfa, tobacco, soybeans, and vegetables are grown. Rather short rotations are in common use, and some fertilization is practiced for most crops. Organic matter is not usually added either through application of manure or the turning under of winter legume crops. Alfalfa and tobacco ordinarily are rather heavily fertilized; a great part of the acreage receives 2 to 3 tons of lime an acre every 6 to 10 years. Under ordinary conditions corn yields about 20 bushels, wheat 10 bushels, and lespedeza 0.7 ton an acre. Pasture is not of high quality and ordinarily produces 40 cow-acre-days of grazing.

This soil is considered suitable for both tilled crops and pasture, but its management requirements are somewhat exacting. Fertility should be kept at a high level, and moderately long rotations consisting chiefly of fall-sown small grains and grasses and legumes for hay and pasture are a necessary part of good management. The rather strong slope and the slow permeability of the subsoil cause runoff to be hazardous where the soil is not well protected by vegetation. Strip cropping and subsoiling may be practical means of restraining erosion.

Areas not required for crops can be brought to a fairly high state of fertility for pasture. Where high fertility and good tilth are established and maintained and erosion is adequately checked, corn will yield 35 bushels and alfalfa about 2.5 tons an acre. Under such conditions the more desirable pasture grasses and legumes maintain a good cover and produce about 85 cow-acre-days of grazing.

Sequoia silty clay loam, severely eroded rolling phase (5-12% slopes) (Ssr).—This phase consists of areas of Sequoia silt loam that have a rolling surface and are so eroded that practically all of the surface soil has been lost. Shallow gullies are common, and some gullies are too large to be obliterated by tillage. The separate areas of this fairly extensive soil are 5 to 40 acres in size and are widely scattered throughout the Sequoia-Leadvale, Sequoia-Litz-Dandridge, and Dandridge-Litz-Leadvale soil associations. Although the predominant slope range is 5 to 12 percent, small tracts on ridge crests have a smoother surface.

The plow layer consists chiefly of reddish-yellow very firm silty clay loam or silty clay. Shale bedrock is at depths of $\frac{1}{2}$ to $1\frac{1}{2}$ feet, but there are places on the more exposed slopes where shale practically outcrops and a few where thin limestone beds outcrop. In some areas the subsoil is more nearly brownish yellow, quite plastic, and similar to that of Colbert silty clay. Because of their small size and close association with Sequoia soils, these Colbert areas were included with this Sequoia soil in mapping.

The natural fertility and content of organic matter are very low for Sequoia silty clay loam, severely eroded rolling phase. The clayey plow layer makes permeability to moisture very slow and causes the soil to puddle easily when wet and to become hard quickly as it dries. The reaction is medium to strongly acid.

Use and management.—All of the acreage has been cleared and cropped at some time. A great part is now idle or used as unimproved pasture. The growth on these areas consists chiefly of sassafras, briars, and broomsedge, with some lespedeza and other grasses intermixed. Small acreages have been improved for pasture or are used for crops, chiefly small grains, hay, and corn. Management on much of the acreage is not at a high level. Erosion is active and yields are usually low.

The rolling surface, low fertility, and slow permeability make this soil rather poorly suited to tilled crops, but it is fairly well suited to pasture if fertility is built to a high level and desirable pasture plants are established. The carrying capacity, however, even under the most favorable conditions, is limited by its droughtiness. Those areas needed for crops generally require organic matter, lime, and plant nutrients. If the soil is to be maintained under cropping, exceptionally long rotations consisting chiefly of fall-sown small grains and grasses and legumes are necessary. Under the most favorable conditions corn should yield about 20 bushels and lespedeza 0.8 ton an acre. The carrying capacity of pasture will be about 50 cow-acre-days under favorable management, but most of the grazing will be confined to the moister parts of the growing season.

Sequoia-Bland silty clay loams, eroded undulating phases (2-5% slopes) (Sn).—In this complex are areas of Sequoia and Bland soils so small and thoroughly intermingled that they could not be de-

cultivation. Steep slope, shallow depth to bedrock, and low natural fertility limit the suitability of the Muskingum-Lehew areas chiefly to forest.

JEFFERSON-MONTEVALLO SOIL ASSOCIATION

The Jefferson-Montevallo soil association (pl. 14, A) occupies valley positions. The underlying rock is predominantly acid shale. Practically all of the areas lie as undulating to rolling strips adjacent to areas of the Muskingum-Lehew soil association. A few steeper narrow strips and a notable acreage of gently sloping or nearly level colluvial soils, chiefly of the Leadvale and Cotaco series, occur along the drains. Jefferson soils predominate on the parts adjacent to the Muskingum-Lehew ridges, and the Montevallo elsewhere.

The soils of this association (pl. 14, B) are generally low in fertility, strongly acid, and, except for the soils on alluvium and colluvium, shallow to shale bedrock. A large part has been cleared and cropped, and as a result most of the upland soils have been moderately to severely eroded. In many places erosion has been so great that the soil will be unsuited for either crops or pasture until extensive measures are taken to fill in the gullies, increase the fertility, and establish a good grass cover. Third- and Fourth-class soils predominate, although Fifth-class soils are common in places. There is a small acreage of Second-class soils.

Farming for production of crops used by the farm family prevails in the less productive parts, and idle land is common. Corn and pasture occupy much of the acreage in such sections, and crop yields and the carrying capacity of pasture are low. In the more productive parts a more general type of farming is practiced, and on a few farms where good management prevails fairly high yields of corn, small grains, hay, and pasture are produced. A large part of the acreage is suited to general farming. In order to establish and maintain a relatively high level of production, however, particularly good management is required, chiefly because the more extensive soils are prevailingly of low fertility and greatly susceptible to erosion.

CUMBERLAND-HUNTINGTON SOIL ASSOCIATION

The Cumberland-Huntington soil association consists of bottom lands and associated high stream terraces along the Holston, French Broad, Tennessee, and Clinch Rivers. Most areas are in the meanders of these streams and are from a fraction of a square mile to about 1½ square miles in size. The separate areas generally consist of an irregular strip or belt of nearly level bottom land adjacent to the river channel and a higher, somewhat broader area of undulating and rolling stream terraces.

Huntington, Staser, and Lindsides soils occupy most of the bottom lands along the Holston, Tennessee, and Clinch Rivers. Undulating and rolling Cumberland, Etowah, and Waynesboro soils predominate on the stream terraces, which are hilly in small areas but on the whole are fairly smooth.

The soils on the bottom lands are fertile, easily worked, and moderately drained to well drained. They were originally subject to periodic flooding, but flooding is much less frequent now that dams have been built upstream. The soils on the stream terraces are mod-

erate to high in fertility and in great part are well drained. There are sufficient cobbles in places to interfere materially with cultivation.

First- and Second-class soils predominate on the bottom lands, and Second-class soils on the terraces. A great part of the acreage in this association has been cleared and is used mainly for crops. Parts of the cleared areas on the terraces are used for pasture grown in rotation with other crops. Much of the bottom land is used intensively for row crops, chiefly corn, although some hay and truck crops are also grown. Rotations are more common on the terraces where corn, small grains, hay, and some truck crops and tobacco are grown. General livestock farming, supplemented by a cash crop, usually tobacco, prevails.

This association is one of the most productive of the county, and crop yields are relatively high. The fertility, especially of the bottom lands, is easily maintained, and the soils of the terraces are well suited to a variety of crops without especially exacting management. Soils on the bottom lands are suited to intensive row cropping and to general livestock farming supplemented by a limited acreage of cash crops.

DECATUR-DEWEY-EMORY SOIL ASSOCIATION

The Decatur-Dewey-Emory soil association occupies irregular valley areas overlying relatively high grade limestone. It mainly occurs adjacent to areas of the Fullerton-Bolton-Clarksville soil association. The surface is predominantly undulating to rolling, and internal drainage of practically all of the soils is moderately good to very good. A large part is occupied by very fertile smooth soils that are at least moderately deep to bedrock. The soils are considered to be strong, and high fertility is not difficult to maintain. First- and Second-class soils predominate, but on the more sloping parts careful attention is required in controlling erosion.

Most of the acreage has been cleared and is used mainly for crops or pasture. General livestock farming prevails; corn, small grains, and legume hay and pasture crops are grown. Some of the most productive farms have a part or all of their acreage in this association, which includes some of the most productive parts of the county. The areas are well suited to livestock farming. They are naturally productive of legumes and grasses, although some liming and fertilization are required to maintain high fertility. Many of the uneroded soils in this association are productive of truck crops, whereas most of the eroded soils are not suited to truck crops because of their poor tilth.

SEQUOIA-LITZ-DANDRIDGE SOIL ASSOCIATION

The Sequoia-Litz-Dandridge soil association (pl. 15, A) consists predominantly of soils developed over interbedded shale and limestone and calcareous shale, which have been weathered to widely variable depths. The association is undulating to hilly and occupies valley positions. It consists of low hills with moderately broad smooth crests and moderately strong slopes, and of narrow strips of imperfectly drained soils on local alluvium along the drains. Sequoia soils are on most of the smooth hill tops and make up about 80 percent of the acreage. Litz and Dandridge soils predominate on the strong slopes, and Leadvale, Whitesburg, and Lindsides soils occupy the alluvial strips.

Internal drainage is moderately slow to medium; surface runoff is medium to very rapid. The general fertility ranges from low to medium for the Sequoia, Litz, and Dandridge soils, and from medium to high for the Leadvale and Lindsides soils.

Third-, Fourth-, and Fifth-class soils predominate, although the Lindsides and some of the Leadvale and Sequoia soils are of the Second class. General farming predominates; corn, wheat, oats, and hay are the chief crops. A great part of this association has been cleared and cropped, but a considerable acreage in the more sloping areas has been severely eroded and greatly lowered in productivity. Much of this eroded acreage is now either idle or used as unimproved pasture.

Strong slope, shallow depth to bedrock, and generally eroded condition make especially careful management necessary if the productivity of the soils in this association is to be built up and maintained. The smoother, less eroded areas are moderately productive of most farm crops and pasture when farmed under a good system of management. The other areas can be made to produce good grazing. A system of farming that maintains a large acreage of pasture and hay crops on the more sloping parts is well suited. Moderately long rotations consisting of hay, small grains, and infrequent row crops are satisfactory on the smoother less eroded Sequoia soils. The Leadvale, Whitesburg, and Lindsides soils are suited to intensive use, providing their fertility is maintained. The Litz, Dandridge, and the severely eroded Sequoia soils are not well suited to crops requiring tillage. This association generally is much less desirable for truck crops than some of the other associations in which deeper, more friable, smooth soils are common.

DANDRIDGE-LITZ-LEADVALE SOIL ASSOCIATION

The Dandridge-Litz-Leadvale soil association differs from the Sequoia-Litz-Dandridge association chiefly in having stronger slopes, prevailingly hilly and steep. It occupies moderately large areas in the northern and eastern parts of the county. Dandridge and Litz soils are much more extensive than Sequoia soils. The average depth to bedrock is notably shallow, and surface runoff on much of the acreage is very rapid. Internal drainage is adequate, but the capacity for holding moisture is limited.

Possibly 35 percent of the acreage has been cleared, and much of the upland has been greatly damaged by erosion. Fourth- and Fifth-class soils prevail on the uplands. Corn, hay, and pasture are the main crops of this association. Much of the acreage now lies idle or has been abandoned to volunteer forest. On some areas farming for home use prevails; on others, livestock farming. Soils well suited to crops requiring tillage are limited chiefly to the narrow strips of bottom land along the streams and drainageways.

Much of this association is not well suited to intensive use, mainly because of strong slope, relatively shallow depth to bedrock, and, in places, severe erosion. If properly fertilized, much of the upland is well suited to pasture and, accordingly, well suited to livestock farming in which long rotations consisting principally of legume hay and pasture crops are used. The more limited but significant and widely

distributed soils on the nearly level valley floors are well suited to intensive farming. Practically every farm in this association has some acreage on these smooth alluvial soils.

TELICO-NEUBERT SOIL ASSOCIATION

The Tellico-Neubert soil association occupies a predominantly hilly to steep landscape in which Tellico soils are the most extensive. A smaller but significant acreage of Neubert and Hamblen soils is on the colluvial slopes and along the drainageways and creeks. The soils generally are a reddish loam that is moderately fertile and permeable. The steeper parts are shallow to bedrock, and those less steep are moderately deep.

Fourth- and Fifth-class soils predominate in this association; but on the ridge tops, most of which are narrow, and on the bottom lands and colluvial slopes Second- and Third-class soils prevail. A large part of the acreage suitable for crops has been cleared. The steepest slopes are not well suited to either crops or pasture and are largely under forest. Some hilly and steep areas once cropped are now under reestablished pine forest. In most parts of the association, forest occupies much of the land.

Farms usually consist mostly of forested areas; the cropland is confined to the broader ridge tops, colluvial slopes, and bottom lands. General farming and truck crop production prevail. The smoother Tellico and Neubert soils are favored, especially for early market vegetables. Some of the hilly slopes are used for pastures that provide good grazing when properly fertilized and protected from erosion.

ARMUCHEE-LEADVALE SOIL ASSOCIATION

The Armuchee-Leadvale soil association is predominantly hilly and steep and shallow to shale and limestone bedrock. It occurs as an irregular belt in the northern part of the county. There are narrow strips of smooth Leadvale soils along the drains, and some rolling areas of Sequoia soils, moderately deep to bedrock, on the ridge tops. Nevertheless, the shallow hilly and steep Armuchee soils greatly predominate.

Probably two-thirds of the association has been cleared, and much of the cleared hilly and steep part has been severely eroded. Some of this has grown up in pine forest.

This association is not well suited to systems of farming in which tillage of a large part of the farm is required. Much of it is not suited to crops, except those grown in very long rotations, but is capable of producing good quality pastures. Bluegrass and white clover grow well where the natural fertility has been replenished or has not been greatly reduced. The steepest and most severely eroded areas cannot be expected to be especially useful as pasture and are suited chiefly to forest. Crops grown in moderate to short rotations are confined mainly to the smooth strips along the drains and creeks.

STASER-HAMBLÉN SOIL ASSOCIATION

The Staser-Hamblen soil association occupies the first bottoms along Bullrun Creek, which is in the northern part of the county. Ham-

blen soils predominate, but Staser soils and soils of low stream terraces occupy a smaller part. In most places the soils are nearly level, of moderate to high fertility, and not especially acid. Practically all the acreage is subject to periodic flooding. This association usually makes up a part of farms that lie in adjacent associations, chiefly the Armuchee-Leadvale. Because the Armuchee-Leadvale does not have a large acreage of soils suited to crops, a great part of the cropped acreage on the farms is within the Staser-Hamblen association.

A large part has been cleared and is used rather intensively for crops on farms producing general livestock. Corn occupies an extensive acreage, and hay, pasture, and some small grains the rest. Yields are moderate under usual conditions but very high under good management.

The soils of this association are not difficult to maintain at a fairly high level of fertility. The workability is good, except where affected by flooding, and erosion is not serious. A small acreage may be damaged by deposits of unproductive sand or clayey subsoil material carried from actively eroding areas in the adjacent upland.

BLAND-CAMP SOIL ASSOCIATION

The Bland-Camp is one of the less extensive soil associations. It occurs in a strongly dissected belt in the eastern part of the county. This belt consists mainly of the hilly and steep dusky red Bland soils but has narrow areas of rolling Bland soils on the ridges and narrow strips of Camp soils along the draws. These soils have moderate natural fertility but their rather slow permeability and predominantly strong slopes promote rapid erosion when the soil is tilled.

A considerable part of the steep and some of the hilly areas are under cut-over native forest. Much of the Camp, as well as smaller but notable parts of the hilly and steep Bland soils, have been cleared. A large part of the hilly and steep and some of the rolling Bland soils have been abandoned as crop land after being severely eroded and have grown up in shortleaf and Virginia pines.

Much of this association is not well adapted to farming, although the Camp and the rolling Bland soils are suited to crops. The size of the suitable areas is small, as they are closely flanked by extensive hilly and steep areas of limited value for pasture or forest.

SEQUOIA-LEADVALE SOIL ASSOCIATION

The Sequoia-Leadvale soil association occupies predominantly undulating to rolling valley positions over calcareous shale and interbedded shale and limestone. On the smoother parts of the low ridges the depth to bedrock is 2 to 3½ feet, but on the more exposed slopes it is less. The alluvial soils along the drains occupy an appreciable acreage and are more than 3 feet deep to bedrock. A great part of the upland has been eroded. Many of the more sloping areas now have a plow layer consisting of clayey subsoil material. There is also an extent of gullied land on areas that were cultivated without adequate control of runoff.

A great part of this association has been cleared (pl. 15, B) and much is now used for general livestock farming. Corn, small grains, and legume and grass hay and pasture crops predominate. In some

places a notable acreage lies idle; its productivity has been greatly reduced by erosion losses.

The soils of this association generally are subject to serious erosion when cultivated and are not among the most fertile in the county. Nevertheless, they are suited to general farming in which livestock production is important. Second- and Third-class soils predominate; Fourth- and Fifth-class soils occupy the more sloping eroded parts. The smoother parts of the upland, chiefly Sequoia soils, are suitable for crops if moderately long rotations are used and adequate fertilization is practiced. The alluvial soils along the streams and drains are well suited to intensive use but will require fertilization to keep yields high. Most of the soils are capable of producing good pasture under proper management.

SEQUOIA-BLAND SOIL ASSOCIATION

The Sequoia-Bland soil association (pl. 16, A), like the Sequoia-Leadvale, occupies undulating to rolling valley positions. It consists of an intricate pattern of Bland and Sequoia soils with strips of Leadvale and Lindsides soils along the drains. The soils are shallow to interbedded shale and dusky red argillaceous limestone bedrock. The range in slope is a little greater than for the Sequoia-Leadvale association and an appreciable part is hilly or strongly sloping.

A great part has been cleared and was frequently cropped in the past (pl. 16, B). Erosion has been active on much of it. General livestock farming is now practiced and appears to be well suited. Corn, hay, small grains, and pasture are important crops. The upland part is not high in productivity because it is eroded and gullied. The limited acreage of soils on local alluvium is of moderate productivity and is suited to such crops as corn and grasses and legumes for hay and pasture. Third- and Fourth-class soils predominate on the upland, and Second-class soils on most of the bottom land.

MONTVALLO SOIL ASSOCIATION

The Montvallo soil association is relatively small. Most of it lies as an irregular narrow strip southeast of Bullrun Creek and parallel to it. It consists predominantly of rolling and hilly Montvallo soils with small colluvial strips along the drains. With the exception of these colluvial areas, the soils are shallow to very shallow to acid shale bedrock. They are low in fertility, medium to strongly acid, and very limited in capacity for holding moisture available to crops. Much of the smoother part has been cleared and cropped at some time but is now largely abandoned or idle. A notable acreage has been very severely eroded and is now in shortleaf and Virginia pines. Parts of the hilly areas are still under native forest.

A great part of this association is poorly suited to crops or pasture. The smoother areas possibly can be made to produce sufficient pasture, though much of the acreage should be returned to forest. The limited areas of colluvial soils are suited to crops; but the strips are so narrow and small that they do not form a farm unit and are not conveniently located to become a part of a farm unit that lies predominantly in another soil association.

TABLE 7.—*Soil series of Knox County, Tenn., classified by soil orders and great soil groups, and factors that have contributed to differences in soil morphology*¹

ZONAL

Great soil group and series	Relief	Parent material	Time ²
Red-Yellow Podzolic: Red members:		Residium weathered from—	
Decatur.....	Undulating to hilly.....	High grade limestone.....	Long.
Dewey.....	Undulating to steep.....	do.....	Do.
Bolton.....	Rolling to steep.....	Arenaceous limestone or limestone with sandy beds.....	Do.
Fullerton.....	Undulating to steep.....	Moderately cherty limestone.....	Do.
Talbott.....	Undulating to hilly.....	Moderately argillaceous limestone.....	Do.
Farragut.....	do.....	High grade limestone over shale.....	Do.
Sequoia ³	do.....	Interbedded shale and limestone and calcareous shale.....	Do.
Cumberland.....	do.....	Mixed general alluvium strongly influenced by—	Do.
Etowah.....	do.....	Limestone.....	Medium.
Waynesboro.....	do.....	do.....	Long.
Nolichucky.....	Rolling.....	Shale, sandstone, and limestone.....	Do.
Alcoa.....	Undulating to rolling.....	Local alluvium chiefly from—	Medium to long.
Bland ⁴	Rolling to steep.....	Tellico soils.....	Short to long.
Tellico ⁴	do.....	Residium weathered from—	Do.
Yellow members:		Dusky-red shaly limestone.....	
Clarksville.....	do.....	Calcareous sandstone.....	
Sequatchie.....	Undulating to rolling.....	Cherty limestone.....	Long.
Jefferson.....	do.....	Mixed general alluvium derived largely from—	Medium.
Leadvale.....	do.....	Sandy rocks.....	Medium to long.
Colbert ⁴	Undulating to hilly.....	Colluvium and local alluvium chiefly from—	Long.
		Muskingum and Lehigh soils.....	
		Dandridge, Armuchee, Sequoia, Litz, Monte- vallo, Muskingum, and Lehigh soils.....	
		Residium weathered from—	
		Argillaceous limestone.....	Short to long.

INTRAZONAL

Planosols:		Mixed alluvium strongly influenced by—	
Wolftever.....	Undulating to rolling.....	Limestone, shale, and sandstone.....	Long.
Guthrie ⁵	Nearly level.....	Chiefly limestone.....	Very long.
Tyler.....	do.....	Chiefly shale.....	Do.

AZONAL

Alluvial soils:		General alluvium strongly influenced by—	
Huntington.....	Nearly level.....	High grade limestone.....	Very short.
Roane.....	do.....	Cherty limestone.....	Do.
Lindside.....	do.....	Limestone.....	Do.
Congaree.....	Nearly level to very gently undulating.....	Micaceous rocks.....	Do.
Chewacla.....	Nearly level.....	do.....	Do.
Staser.....	Nearly level to very gently undulating.....	Chiefly shale.....	Do.
Hamblen.....	Nearly level.....	do.....	Do.
Emory.....	Undulating to rolling.....	Local alluvium chiefly from—	Very short to long.
Greendale.....	do.....	Decatur, Dewey, and Farragut soils.....	Do.
Camp.....	Gently sloping to sloping.....	Fullerton and Clarksville soils.....	Do.
Abernathy.....	Nearly level.....	Bland soils.....	Do.
Ooltewah.....	do.....	Chiefly Decatur, Dewey, and Farragut soils.....	Very short.
Whitesburg.....	Undulating to rolling.....	do.....	Do.
Cotaco.....	do.....	Dandridge, Armuchee, Litz, and Sequoia soils.....	Do.
Neubert.....	do.....	Muskingum, Lehigh, and Jefferson soils.....	Do.
Melvin ⁶	Nearly level.....	Tellico soils.....	Do.
Prader ⁶	do.....	Limestone.....	Short.
		Shale.....	Do.

See footnotes at end of table.

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KNOX COUNTY, TENNESSEE

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TABLE 7.—Soil series of Knox County, Tenn., classified by soil orders and great soil groups, and factors that have contributed to differences in soil morphology.—Continued

AZONAL—Continued

Great soil group and series	Relief	Parent material	Time ²
Lithosols:		Residium weathered from— Interbedded limestone and shale.	Medium to very short.
Armuchee	Hilly to steep.	Calcareous shale.	Do.
Dandridge	do.	Leached shale.	Do.
Lutz	do.	Acid shale.	Short to very short.
Montevallo	Undulating to steep.	Chiefly sandstone.	Medium to very short.
Muskingum	Hilly to steep.	Dusky-red sandy shale.	Do.
Lehew	do.		

¹ Inasmuch as climate and vegetation are relatively uniform over the county, they cannot account for the broad differences in the soils.

² The length of time that the material has been in place as indicated by the degree of profile development.

³ The Sequoia profile is partly within the range of the Red members and partly within that of the Yellow members.

⁴ These soils are relatively shallow to bedrock, have weakly

differentiated or thin B horizons, and are considered, therefore, to be intermediate between zonal soils and the azonal Lithosols. They are frequently described as being lithosolic.

⁵ Some of the Guthrie soil as mapped in Knox County classifies as alluvial soil with gley horizon.

⁶ These soils have gley horizons. Under recent refinements in classification, they would be classed as Low Humic Gley soils.

MORPHOLOGY OF SOILS REPRESENTING THE GREAT SOIL GROUPS

RED-YELLOW PODZOLIC SOILS

RED MEMBERS

The red members of the Red-Yellow Podzolic great soil group (16) are zonal soils having thin organic and organic-mineral layers over a yellowish-brown leached layer which rests upon an illuvial red horizon. They developed under a deciduous or mixed forest in a warm-temperate moist climate. The soil-forming processes involved in their development are laterization and podzolization. The red members in Knox County are listed in table 7.

These soils apparently have all developed under relatively similar conditions of climate and vegetation. They are well drained, and although they range somewhat in degree of maturity, all are old enough to have at least a moderately well developed Red-Yellow Podzolic soil profile. They range from undulating to steep. Profile differences are probably not caused primarily by variance in slope gradient. Many profile differences can be correlated with marked differences among parent materials.

Decatur series

The soils of the Decatur series have thick solums and have developed from high grade limestone on undulating to steep areas in the uplands. They have few rock outcrops except in severely eroded places. Since they are among the most productive and well-developed soils in the county, they probably supported some of the most luxuriant vegetation. As a natural result they have a darker A horizon than any of the other well-developed soils—an indication of a higher content of organic matter. The luxuriant vegetative growth also tended to inhibit erosion and to develop a friable surface soil and subsoil.

A typical Decatur profile follows:

- A, 0 to 12 inches, dark-brown to dark reddish-brown (7.5YR 3/2 to 5YR 3/2), friable heavy silt loam with a moderately well-developed medium crumb structure.
- B, 10 to 18 inches, yellowish-red (5YR 4/8) to reddish-brown friable silty clay loam with a weakly developed fine to medium blocky structure.
- B, 18 to 42 inches, red (2.5YR 4/6) or dark-red plastic silty clay with a well-developed medium to coarse blocky structure; structure faces glossy and darker than the crushed material; many dark-gray to black concretions, usually less than one-fourth inch in diameter.
- B, 42 to 70 inches, reddish-brown or yellowish-red firm to plastic silty clay; structural particles larger and less distinct than in layer above; a few weathered, soft, powdery chert fragments.
- C 70 to 90 inches +, reddish-brown or yellowish-brown firm to plastic silty clay or clay lightly spotted and streaked with red, brown, yellow, and gray; bedrock at 12 to 30 feet in most places.

Dewey series

The soils of the Dewey series developed from high grade limestone, apparently higher in insoluble impurities, particularly silica, than the rocks underlying the Decatur soils. They are generally somewhat

¹ Soil color names are those adopted by the 1948 Committee; symbols following names are Munsell color notations.

Farragut series

The Farragut soils have developed from materials weathered from a thin bed of limestone over shale. The parent materials differ from those of Sequoia soils in having a higher proportion of limestone, and from the Decatur soils in having a shaly substratum at depths ranging from 18 to 48 inches. Farragut soils essentially consist of a shallow Decaturlike solum resting on disintegrated acid shale. They occupy valley positions similar to those of the Decatur and many areas of the Sequoia soils. They are fertile and medium to strongly acid. The predominant slope range is undulating to rolling. The native vegetation was predominantly oaks, hickories, and associated deciduous hardwoods.

A representative profile of Farragut soil (silt loam) is as follows:

- 0 to 8 inches, brown (7.5YR 4/2, dry) or dark reddish-brown (5YR 8/3, moist) friable silt loam; lower part may be lighter brown and finer textured; under virgin conditions layers may be 10 to 12 inches thick, with the surface 2 inches darker and of higher organic content.
- 8 to 12 inches, gradation from brown to reddish-brown friable silty clay loam; moderately developed firm blocky structure.
- 12 to 20 inches, reddish-brown (5YR 4/4 to 4/6) firm plastic silty clay; in places may be more nearly yellowish brown.
- 20 to 40 inches, yellowish-brown to yellowish-red (5YR 4/8 to 7.5YR 5/8) firm plastic silty clay with some reddish and gray mottles and some dark concretions; lighter brown with depth; thickness varies greatly; underlying soft variegated brownish-yellow and gray shaly material is at depths ranging from 18 to 48 inches.

Sequoia series

The Sequoia soils have developed from the weathered products of interbedded shale and limestone and from calcareous shale. The parent material contains less limestone than that of the Farragut soils but more than that of the Montevallo and Litz soils. This difference in parent material is apparently the cause of the differences among these series. The Sequoia soils have parent material similar to that of the Armuchee soils, but differ from them in occupying milder relief and are therefore subject to slower geologic erosion. As a result they have developed zonal profiles, whereas the Armuchee soils have developed only azonal profiles.

The Sequoia soils, compared with soils such as the Fullerton, Clarksville and Dewey, are shallow to bedrock but have relatively strong textural and structural zonal profile characteristics. That is, the illuviated layer of the Sequoia has a decidedly finer texture and a relatively strong moderate blocky structure in contrast to the silt loam texture and weak crumb or granular structure of the eluviated layer. The Sequoia soils are moderate in fertility, moderately well drained internally, and medium to strongly acid.

A representative profile of a Sequoia silt loam follows:

- 0 to 8 inches, very pale-brown (dry) or light yellowish-brown to yellow (moist) friable silt loam with a weak fine granular structure; under virgin conditions surface inch darker (10 YR 6/4 to 7/6).
- 8 to 14 inches, reddish-yellow (7.5YR 6/8) firm silty clay loam with moderate to well-developed blocky structure.

14 to 22 inches, reddish-yellow (7.5YR 5/8) to strong brown very firm plastic somewhat waxy (compact when dry) silty clay that has a moderate to well-developed medium blocky structure; may contain small dark concretions and in the lower part some partially weathered shale fragments.

22 inches +, mottled yellow, red, and gray very firm plastic silty clay.

Shale is at depths of 18 to 42 inches. In many places, to a depth of several feet, it is soft, evidently leached, calcareous shale. In other places calcareous shale is within 6 or 8 inches of the lower edge of the solum. In some landscapes there are limestone interbeds in the shale.

Cumberland series

The Cumberland soils are well developed red members of the Red-Yellow Podzolic soils. They formed from high-lying very old deposits of mixed alluvium strongly influenced by limestone. The predominate slope is undulating to rolling, although an appreciable part is hilly. The relatively high fertility of these soils, together with favorable moisture conditions, appears to have supported a heavy forest growth that left a relatively high content of organic matter in the upper layer. The Cumberland resemble the Decatur soils in many properties but are generally deeper and more friable and have some cobbles and pebbles in the profile. Commonly an irregular gravelly bed is directly above the underlying sedentary material. These soils are medium to strongly acid throughout.

A representative profile follows:

- 0 to 8 inches, brown (7.5YR 5/4 to 4/4) mellow silt loam; under virgin conditions has a thickness of 12 inches, a decidedly darker surface 2 inches, and much organic matter.
- 8 to 16 inches, yellowish-red (5YR 4/8) friable silty clay loam.
- 16 to 40 inches, red to dark-red (2.5YR 4/6 to 8/6) firm but somewhat friable silty clay with a weakly developed medium blocky structure.
- 40 inches +, yellowish-red firm but moderately friable silty clay or silty clay loam that may have yellow and gray reticulations.

A small quantity of quartzite pebbles occurs throughout the soil, and in places quartzite cobbles are abundant. In many places a gravelly bed, varying in thickness and amount and size of gravel, is below this layer. The sedentary, or underlying, bedrock is at depths of 4 to 20 feet. In general the shallower depths to bedrock occur on the more sloping parts.

Etowah series

The soils of the Etowah series consist of materials comparable to those of the Cumberland soils. The chief difference is that the Etowah soils are somewhat younger in profile development. They are generally on lower stream terraces and have a smoother relief, a lighter red color throughout the profile, and a more friable subsoil. Areas of Etowah and Cumberland soils along the French Broad River contain a noticeable amount of mica, which indicates an admixture of material from micaceous rock.

Representative profile:

- 0 to 7 inches, grayish-brown to dark grayish-brown (10YR 5/2 to 4/2) silt loam; under virgin conditions the surface 1 to 2 inches is dark brown.
- 7 to 30 inches, strong brown (7.5YR 5/6 to 5/8), approaching yellowish-red, friable silty clay loam of weak nut structure.

10 to 30 inches, red (2.5YR 4/6, dry) or dark-red (2.5YR 3/6, moist) friable clay loam or sandy clay loam with a medium, moderately developed, blocky structure; firm when dry.

30 inches +, predominantly reddish brown friable fine sandy loam or clay loam with streaks and splotches of yellow and brown; material becomes looser and more sandy with depth and in places is nearly free of sand; in some areas the underlying material is hard grayish or pinkish calcareous sandstone that has the appearance of blue-stone, in others it is soft laminated brown, yellow, and very dark-olive sandy shale-like residuum.

YELLOW MEMBERS

The yellow members of the Red-Yellow Podzolic great soil group (16) are zonal soils having thin organic and organic-mineral layers over a grayish-yellow leached layer that rests on a yellowish horizon. These soils in Knox County (see table 7) have undulating to steep relief and were developed under a forest vegetation that consisted mainly of deciduous trees with an admixture of pines in places. There may have been more pines and a somewhat less luxuriant and different kind of undergrowth on the yellow members than on the red members of the Red-Yellow Podzolic soils of the area. The degree to which there was uniformity in such a relationship is unknown. Climatic conditions for soils of the two groups were apparently similar.

The causes for development of pronounced color differences between the yellow and the red members are not known. It appears, however, that the yellow members of the county generally have parent materials either lower in bases or less well drained internally than the parent materials of the red members. The parent materials for the yellow members were derived from cherty limestone, interbedded limestone and shale, pure shale, and old alluvium.

Clarksville series

The Clarksville soils developed from cherty dolomitic limestone. They are noted for their chertiness, light-gray surface layer, yellowish subsoil, and great depth to bedrock. Internal drainage is moderate, and the content of organic matter and plant nutrients usually is notably low. There is some evidence that Clarksville soils do not hold plant nutrients so well as the Decatur, Dewey, and other red members.

The Clarksville soils developed on undulating to steep relief, and relatively young profiles on steeper relief are included in the mapping. The reaction of the soils is strongly acid.

A representative profile:

0 to 8 inches, pale-yellow or virtually gray (dry) or light yellowish-brown (10YR 6/4, moist) cherty silt loam; virgin areas have a thin layer containing partly disintegrated organic matter.

8 to 20 inches, pale-yellow (2.5Y 7/4) cherty silt loam.

20 to 50 inches, strong-brown (7.5YR 5/8) or brownish-yellow (with some yellow and gray splotches in the lower part) firm cherty silty clay loam or cherty silty clay.

50 inches +, variegated or reticulated reddish-yellow, yellow, and gray firm to very firm cherty silty clay; cherty dolomitic limestone bedrock at depths of 20 to 40 feet.

Sequatchie series

The Sequatchie soil developed on low stream terraces consisting of mixed general alluvium that contains a notable amount of sandy ma-

terial. The profile is much less strongly developed than that of many other zonal soils. Most areas lie approximately 15 feet above the adjoining bottoms and have an undulating or gently billowy surface. The soil is well drained, medium acid in most places, permeable, and of moderate fertility. It has a moderate content of organic matter.

Description of a typical profile:

0 to 10 inches, pale-brown (dry) or brown (10YR 4/3, moist), friable fine sandy loam.

10 to 18 inches, yellowish-brown (dry) or brown (7.5YR 4/4, moist) moderately firm fine sandy clay loam with a medium, moderate to weak, nut structure.

18 to 30 inches, brownish-yellow to yellowish-brown (dry) or strong brown (moist) moderately firm fine sandy clay loam with a moderately developed nut structure; material variable below this depth—in some places grades to lighter colored more sandy material, in others to finer textured material with occasional mottles.

Jefferson series

Jefferson soils occur on gently sloping foot slopes below the steep ridges of Muskingum and Lebew soils. They developed on old colluvium or local alluvium from these soils. Most areas have well-developed zonal profiles. Nevertheless, the underlying, sedentary shale beds are in many places at such shallow depth as to cause the Jefferson solum to be thin. The content of organic matter is low, and the general level of fertility is not high. The reaction is medium to strongly acid. The solum is permeable, but the underlying shale interferes somewhat with percolation of moisture.

Description of a representative profile:

0 to 8 inches, yellowish-gray or very pale-brown (dry) or pale-brown (10YR 6/8, moist) loam; in virgin areas the surface inch is dark gray (10YR 4/1) and contains much partly disintegrated organic matter.

8 to 22 inches, brownish-yellow (10YR 6/8, dry) or yellow friable fine sandy clay loam with a medium, moderately developed, nut structure.

22 to 30 inches, mottled or reticulated yellow, strong-brown, and gray moderately firm but friable clay loam; mottles weak in the upper part but strong in the lower; shale bedrock at depths of 2 to 12 feet.

There are some pebbles and sandstone fragments in the profile and on the surface in places.

Leadvale series

The Leadvale soils have developed on moderately old to old local alluvium that came chiefly from soils developed over shales. They are closely associated with Cotaco and Whitesburg soils and are mapped with them in undifferentiated units. The Leadvale soils have shale within a depth of 4 to 8 feet in most places, although it may be as deep as 15 feet. Internal drainage is moderately slow, as indicated by the predominantly mottled condition below a depth of about 24 inches. The soils generally are low in organic matter and plant nutrients; they are medium to strongly acid even in the areas where the parent alluvium was derived from calcareous shale. The Leadvale solum is well developed, and in many places the mottled layer may be sufficiently compact to allow classifying Leadvale soil as a Planosol.

Tyler series

The Tyler soil is a poorly drained Planosol occurring in gentle depressions. In some places the parent material is mixed general alluvium, and in others it is local alluvium derived mainly from soils developed from shales. Like the Guthrie soil, it is predominantly gray and has a compact or tight subsoil. Internal drainage and surface runoff are very slow. The natural fertility is low, and the reaction is medium to strongly acid.

Following is a description of a profile of Tyler silt loam:

- 0 to 6 inches, light-gray (10YR 7/2, dry) or grayish-brown (10YR 5/2, moist) friable silt loam; very dark-brown and yellow mottlings common to this layer; virgin areas have a notable amount of partly disintegrated organic matter in the surface inch.
- 6 to 12 inches, very pale-brown (10YR 7/3, dry) very firm silty clay loam to clay with gray and yellow mottlings.
- 12 to 36 inches, mottled gray and yellow very firm clay.

ALLUVIAL SOILS

The Alluvial great soil group (16) consists of an azonal group of soils developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the material by soil-forming processes. In this county these soils (see table 7 p. 221) are on first bottom lands along streams, in depressions, and along drainageways that extend into the upland areas that have nearly level, gently sloping, and depressional relief and good to very slow internal drainage. They have the common properties of soils that lack a soil profile with genetically related horizons. The properties of these soils are closely related to the alluvial deposits. Alluvial soils derived from similar parent material but differing in drainage have been divided according to properties associated with good, imperfect, or poor drainage.

Huntington-Lindside-Roane-Melvin series

The Huntington, Lindside, and Melvin series constitute a catena of soils derived from mixed general alluvium that apparently has been strongly influenced or dominated by limestone material. Much of their acreage is only slightly acid, and parts may be neutral. Huntington soils are well drained, Lindside imperfectly drained, and Melvin poorly drained. The profiles are not well defined and are considered young to very young. In some places very recent deposits of alluvium are on the surface, and exposure of the profile shows a somewhat older darker surface layer at depths ranging from 6 to 24 inches.

Following is a profile description of Huntington silt loam:

- 0 to 12 inches, brown (10YR 5/3, dry) or very dark grayish-brown (10YR 3/2, moist) silt loam.
- 12 to 30 inches, grayish-brown to brown (10YR 5/2 to 5/3, dry) or very dark grayish-brown (10YR 3/2, moist) heavy silt loam that breaks rather easily to irregular moderate-sized fragments.
- 30 to 50 inches +, pale-brown (10YR 6/3, dry) or brown (10YR 4/3, moist) silt loam to silty clay loam.

The upper 14 to 16 inches of the Lindside soil is quite similar to that of the Huntington. The Lindside profile differs chiefly in being mottled yellow, gray, and brown below this depth. In many places

the Lindside texture is finer and the consistence a little heavier than for the Huntington soils, but these differences are not consistent.

The Melvin soil is classed as an Alluvial soil with a gley horizon. Under average conditions the entire profile is relatively gray as compared to that of the Huntington or Lindside soils, and the subsoil is decidedly gray. In some places there is a layer of very recent alluvium, 6 to 14 inches thick and lighter colored than the somewhat older former surface layer directly below. Some areas of Melvin soil have taken on some characteristics of a Planosol—the subsoil is more compact and clayey than the surface layer.

Following is a description of a Melvin profile:

- 0 to 6 inches, brownish-gray or very pale-brown (10YR 7/3, dry) silt loam; brown mottlings or specks common; in virgin areas surface three-fourths inch or inch contains a notable amount of partly disintegrated organic matter.
- 6 to 20 inches, mottled gray, yellow, and strong-brown moderately plastic silty clay loam; in a few places may be silty clay; crushed mass very pale brown (10YR 7/4, dry).
- 20 inches +, light-gray, mottled with yellow and brown, plastic silty clay; crushed mass white to pale yellow (2.5Y 8/2 to 8/4, dry).

The Roane soil differs from the Huntington soils chiefly in its lighter color, notable amount of chert, lower fertility, and medium acid reaction. In places the cherty matrix at a depth of 24 to 30 inches may be partly cemented, forming a compact mass that is penetrated with difficulty. The Huntington, Lindside, and Melvin soils are on the bottom lands of the large streams such as the Holston and French Broad Rivers as well as the creeks. The Roane soil is confined to smaller stream bottoms where most of the alluvium originated from Clarksville and Fullerton soils.

Following is a description of Roane silt loam:

- 0 to 14 inches, brown friable silt loam (10YR 5/3, dry) or brown to dark-brown (10YR 4/3 to 4/2, moist) silt loam to loam with some chert.
- 14 inches +, white to light-gray (10YR 8/2 to 7/2, dry) very cherty silty matrix; in some places browner, but on the whole light colored; in places mottled.

Staser-Hamblen-Prader series

The Staser, Hamblen, and Prader soils consist of young mixed general alluvium that originated mostly from soils developed over shales. In other words, the parent material for these soils is less influenced by limestone than that of the Huntington group.

This catena includes (1) the fine sandy loams of the bottom lands, which are associated with Huntington, Lindside, and Melvin soils; (2) the soils on the creek bottoms, which have been less influenced by limestone; and (3) the soils on the bottom lands, which consist of materials originating from Tellico soils. In general the soils of this catena are a little lower in fertility and more acid than those of the Huntington, Lindside, and Melvin catena. Nevertheless, they are not strongly acid. The profiles of the Staser and Hamblen soils are less brown than those of the Huntington and Lindside respectively.

Following is a description of the Staser silt loam profile:

- 0 to 12 inches, grayish-brown or light yellowish-brown (10YR 6/4, dry) silt loam.
- 12 to 24 inches, light grayish-brown (10YR 6/3, dry) heavy silt loam.

12 to 24 inches, grayish-brown (10YR 5/2, dry) or dark grayish-brown or dark-brown (10YR 3/2, moist) silty clay loam that comes from place in moderately firm pieces.

24 inches +, mottled yellow and gray silty clay loam; in most areas mottling is at a shallower depth, and the dark layer at 12 to 24 inches, representing a buried surface layer, is not always present.

Whitesburg, Cotaco, and Neubert series

Soils of the Whitesburg, Cotaco, and Neubert series consist of young local alluvium. The Whitesburg is composed principally of material from soils over calcareous shale, chiefly Dandridge and Litz soils; the Cotaco, of material derived from sandstone or sandy shale, chiefly Muskingum, Lebew, and Jefferson soils; and the Neubert, of material chiefly from Tellico soils. All are along drainageways that rise in areas of the upland soils listed. Internal drainage of much of the acreage of Whitesburg and Cotaco soils is moderately poor, whereas the Neubert soils are moderately well drained. All of these soils have weakly or very weakly developed profiles and commonly consist of an Alluvial soil profile buried by a very recent deposit of lighter colored alluvium.

The Whitesburg profile consists predominantly of 10 inches or more of brownish-gray silt loam over light-yellow silt loam that extends to a depth of 18 inches. Below this is mottled yellow and gray friable silty clay loam. Most of this soil is weakly acid to neutral.

The Cotaco soil consists of 8 or 10 inches of yellowish-gray fine sandy loam, below which is yellow friable fine sandy clay loam. Below a depth of about 20 inches is mottled yellow, gray, and brown friable very fine sandy clay loam or silty clay loam. This soil is medium to strongly acid.

The Neubert soils consist of about 12 inches of reddish-brown (5YR 5/3, dry) loam underlain by reddish-brown or brownish-red friable clay loam. These soils are noticeably permeable in most places and medium acid.

LITHOSOLS

The Lithosol great soil group (16) is an azonal group of soils having no clearly expressed soil morphology and consisting of a freshly and imperfectly weathered mass of rock fragments, largely confined to steeply sloping land. The positions these soils occupy (see table 7) are conducive to relatively rapid geologic erosion. The soils generally consist of materials that are easily eroded. As a result, material is removed from the surface or so mixed that soil-forming processes have not acted on it long enough to produce well-defined genetic soil properties. As mapped these soils may include small areas of zonal soils.

Armuchee series

Well defined A, B, and C horizons have not developed in the Armuchee soils; cultivation and accelerated erosion have tended to obliterate the incipient horizon differentiation found in virgin areas. These soils have developed on hilly to steep relief from weathered products of interbedded limestone and shale similar to those underlying the Sequoia soils. Normal erosion in the Armuchee soils, however, has kept pace with weathering processes, and the well-defined A, B, and C profile of the Sequoia soil has not developed. The difference between the Armuchee and the Litz soil apparently results

from the higher percentage of limestone in the parent rock of the Armuchee series.

A representative Armuchee profile is as follows:

- 0 to 1 inch, dark-gray, very friable silt loam, high in organic matter.
- 1 to 6 inches, brownish-gray friable silt loam with a weak, medium crumb structure.
- 6 to 20 inches, reddish-yellow to yellowish-red plastic silty clay spotted with red, yellow, gray, and brown; numerous shale fragments.
- 20 inches +, interbedded shale and limestone; the lime is leached out of the upper 1 to 2 feet in most places.

In some places slight illuviation is recognizable in a layer lying between depths of 6 and 12 inches. In this layer the material is a uniform reddish-yellow silty clay with medium, weakly developed, blocky structure.

Dandridge series

The soils of the Dandridge series have formed from the residuum of calcareous shale. They are predominantly hilly to very steep. On such areas natural erosion apparently has been almost rapid enough to keep pace with soil development; consequently, the soils are shallow, contain numerous shale fragments, and have very weakly developed profiles. These soils are neutral to slightly acid.

Representative profile:

- 0 to 1 inch, brownish-gray very friable silt loam stained dark with organic matter.
- 1 to 6 inches, yellowish-gray friable shaly silt loam.
- 6 to 24 inches, brownish-yellow to reddish-yellow moderately plastic shaly silty clay loam; contains large amount of soft partially disintegrated shale fragments; layer lighter in the lower part and mottled with yellow and gray.
- 24 inches +, calcareous shale bedrock.

Litz series

The Litz soils have developed chiefly from soft acid shale interbedded with widely spaced layers of limestone or calcareous shale that is leached to a depth of several feet. In some of the parent material the layers of limestone have disappeared through weathering, and only shale remains at the surface. The parent rocks differ from those of the Armuchee in containing much less limestone.

The Litz soils are prevailingly very shallow—shallower and lighter colored than the Armuchee soils. They typically range from about 4 to 14 inches in depth to shale. The soil material is predominantly grayish-yellow friable silt loam to silty clay loam. Shale fragments are generally numerous throughout the soil mass. In woods and old pastures the topmost 1 or 2 inches of soil is stained dark with organic matter. The soil is prevailingly moderately to strongly acid. In a few places there is a weakly developed profile somewhat similar to that of the Sequoia soils.

Following is a typical profile:

- 0 to 4 inches, yellowish-gray silt loam; under virgin conditions the upper part of the layer contained a notable amount of partly disintegrated organic matter.
- 4 to 12 inches, brownish-yellow or reddish-yellow firm but friable silty clay loam that may contain some shale fragments; variegated brown, yellow, and red soft shale below this; dark-gray calcareous shale may be at a depth of about 5 feet.

" Rainfall Frequency Atlas of the United States "

USDC. 1993. Rainfall Frequency Atlas of the United States. U.S. Department of Commerce, Hydrologic Services Division. July. Chart 44, page: 95.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

U.S. DEPARTMENT OF COMMERCE
LUTHER H. HODGES, Secretary

FEB 13 1995
WEATHER BUREAU
F. W. REICHELDERFER, Chief

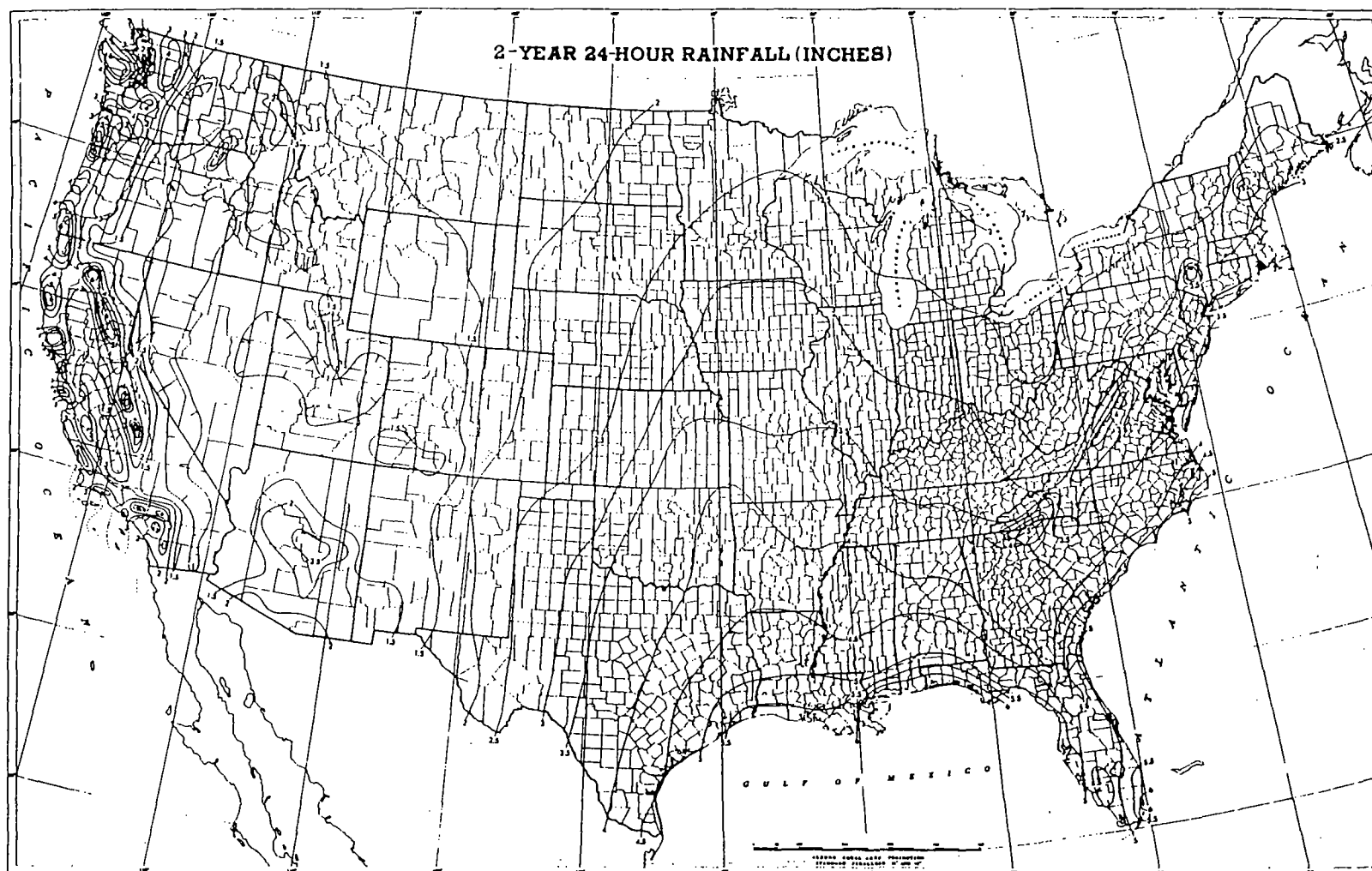
TECHNICAL PAPER NO. 40

RAINFALL FREQUENCY ATLAS OF THE UNITED STATES

for Durations from 30 Minutes to 24 Hours and
Return Periods from 1 to 100 Years

Prepared by
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Cooperative Studies Section, Hydrologic Services Division
for
Engineering Division, Soil Conservation Service
U.S. Department of Agriculture





" Climatic Atlas of the United States "

USDC/NOAA. 1968. Climatic Atlas of the United States. U. S. Department of
Commerce, National Oceanic and Atmospheric Administration. June. page:
78

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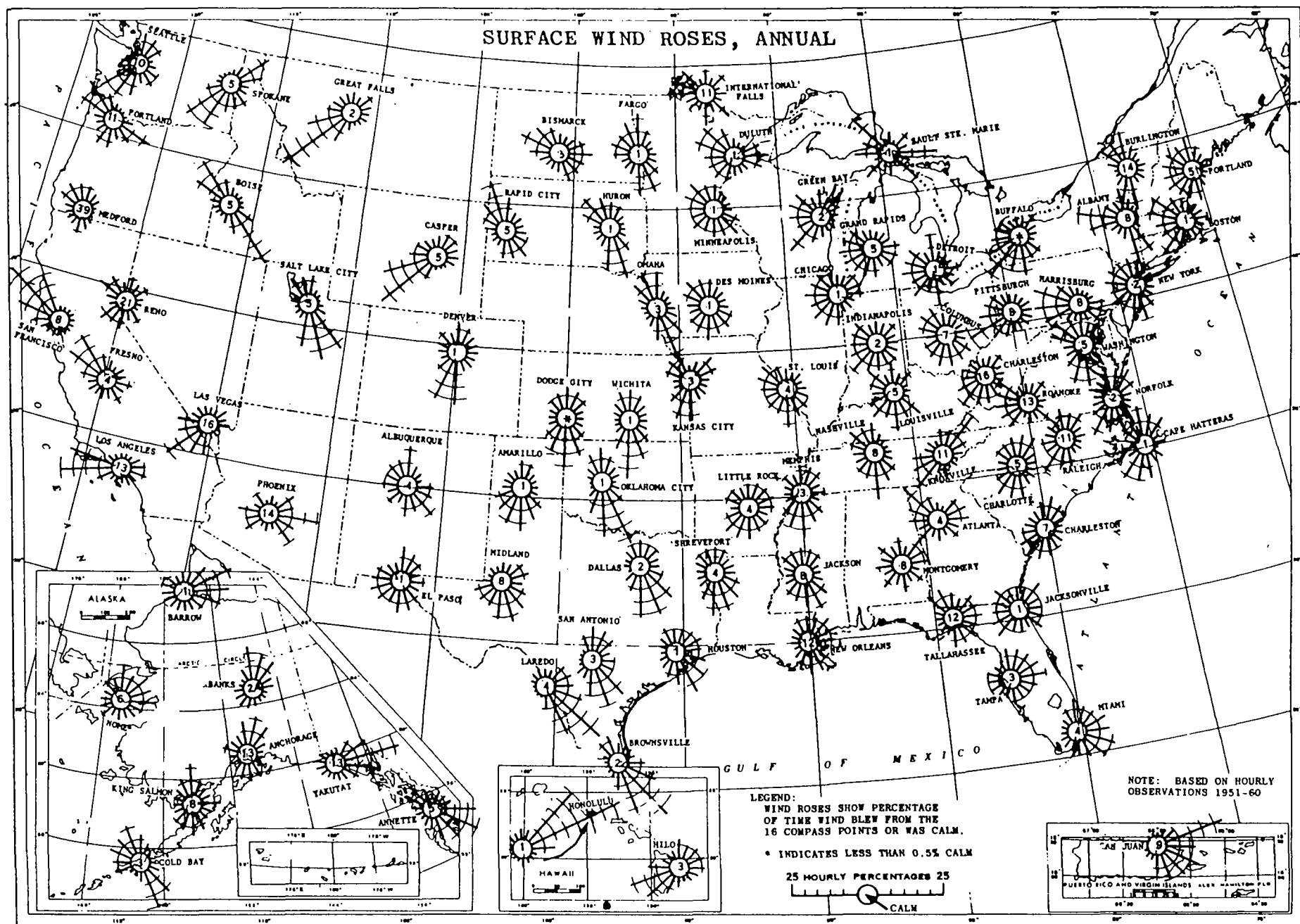
; RESULTANT SURFACE WINDS, MIDSEASONAL - Continued

ANNUAL PERCENTAGE FREQUENCY OF WIND BY SPEED GROUPS
AND THE MEAN SPEED

STATE AND STATION	0 - 3 m.p.h.	4 - 7 m.p.h.	8 - 12 m.p.h.	13 - 18 m.p.h.	19 - 24 m.p.h.	25 - 31 m.p.h.	32 - 38 m.p.h.	39 - 46 m.p.h.	47 m.p.h. and over	Mean speed m.p.h.	STATE AND STATION	0 - 3 m.p.h.	4 - 7 m.p.h.	8 - 12 m.p.h.	13 - 18 m.p.h.	19 - 24 m.p.h.	25 - 31 m.p.h.	32 - 38 m.p.h.	39 - 46 m.p.h.	47 m.p.h. and over	Mean speed m.p.h.	STATE AND STATION	0 - 3 m.p.h.	4 - 7 m.p.h.	8 - 12 m.p.h.	13 - 18 m.p.h.	19 - 24 m.p.h.	25 - 31 m.p.h.	32 - 38 m.p.h.	39 - 46 m.p.h.	47 m.p.h. and over	Mean speed m.p.h.
ALA. Birmingham	27	22	30	17	3	1	*	*	*	7.9	KANS. Topeka	11	19	30	27	10	2	*	*	*	11.2	OKLA. (Cont.) Tulsa	9	24	34	26	7	1	*	*	*	10.6
Mobile	7	28	38	20	6	1	*	*	*	10.0	Wichita	4	12	30	31	16	5	1	*	*	13.7	OREG. Medford	47	31	14	6	2	*	*	*	*	4.6
Montgomery	31	29	27	12	2	*	*	*	*	6.9	KY. Lexington	8	25	39	22	6	1	*	*	*	10.1	Portland	28	27	25	16	4	1	*	*	*	7.7
ALASKA, Anchorage	28	35	25	11	2	*	*	*	*	6.8	Louisville	17	28	31	20	3	1	*	*	*	8.8	Salem	25	32	28	13	2	*	*	*	*	7.1
Cold Bay	4	9	18	27	21	14	5	2	*	17.4	LA. Baton Rouge	17	29	34	17	3	*	*	*	8.3	PA. Harrisburg	28	31	25	13	3	1	*	*	*	7.3	
Fairbanks	40	35	19	5	1	*	*	*	*	5.2	Lake Charles	19	31	29	17	4	1	*	*	*	8.5	Philadelphia	11	27	35	21	5	1	*	*	*	9.6
King Salmon	11	20	30	24	10	4	1	*	*	11.4	New Orleans	16	27	32	19	5	1	*	*	*	9.0	Pittsburgh	12	26	34	22	4	1	*	*	*	9.4
ARIZ. Phoenix	38	36	20	5	1	*	*	*	*	5.4	Shreveport	12	26	37	21	4	1	*	*	*	9.5	Scranton	11	33	35	18	2	*	*	*	*	8.8
Tucson	18	35	30	14	3	1	*	*	*	8.1	MAINE, Portland	10	30	33	22	4	1	*	*	*	9.6	R. I. Providence	11	20	32	28	7	2	*	*	*	10.7
ARK. Little Rock	12	30	39	16	2	*	*	*	*	8.7	MD. Baltimore	7	24	39	22	6	2	*	*	*	10.4	S. C. Charleston	12	28	35	19	4	1	*	*	*	9.2
CALIF. Bakersfield	35	30	24	10	1	*	*	*	*	5.8	MASS. Boston	3	12	33	35	12	4	1	*	*	13.3	Columbia	25	35	26	12	2	*	*	*	*	7.0
Burbank	52	26	18	4	1	*	*	*	*	4.5	MICH. Detroit (City AP)	8	23	37	26	5	1	*	*	*	10.3	S. DAK. Huron	10	18	29	29	10	3	1	*	*	11.9
Fresno	30	41	22	7	1	*	*	*	*	6.1	Flint	16	26	32	22	3	1	*	*	*	9.0	Rapid City	15	22	28	21	10	4	1	*	*	11.0
Los Angeles	28	33	27	11	1	*	*	*	*	6.8	Grand Rapids	14	23	32	25	5	1	*	*	*	9.8	TENN. Chattanooga	39	25	24	11	1	*	*	*	*	6.1
Oakland	26	28	28	16	2	1	*	*	*	7.5	MINN. Duluth	6	15	33	31	11	4	1	*	*	12.6	Knoxville	29	29	25	12	4	1	*	*	*	7.5
Sacramento	15	28	31	18	5	1	*	*	*	9.3	Minneapolis	8	21	34	28	9	2	*	*	*	11.2	Memphis	14	26	34	20	5	1	*	*	*	9.4
San Diego	28	38	28	6	*	*	*	*	*	6.3	MISS. Jackson	33	25	26	14	2	*	*	*	7.1	Nashville	27	31	25	14	2	*	*	*	*	7.2	
San Francisco	16	21	26	22	11	3	*	*	*	10.6	MO. Kansas City	9	29	35	23	5	1	*	*	*	9.8	TEX. Amarillo	5	15	32	32	12	4	1	*	*	12.9
COLO. Colorado Springs	9	27	38	19	6	2	*	*	*	10.0	St. Louis	10	29	36	21	3	1	*	*	*	9.3	Austin	13	25	34	23	5	1	*	*	*	9.7
Denver	11	27	34	22	5	2	*	*	*	10.0	Springfield	4	13	34	32	13	3	1	*	*	12.9	Brownsville	10	17	25	30	14	3	*	*	*	12.3
CONN. Hartford	13	26	32	24	6	1	*	*	*	9.8	MONT. Great Falls	7	19	24	24	15	9	3	1	*	13.9	Corpus Christi	11	16	26	33	12	2	*	*	*	11.9
D.C. Washington	11	26	35	22	5	1	*	*	*	9.7	NEBR. Omaha	12	17	29	28	11	3	*	*	*	11.6	Dallas	9	21	32	28	9	1	*	*	*	11.0
DEL. Wilmington	15	31	30	19	4	1	*	*	*	8.8	NEV. Las Vegas	18	26	25	20	8	3	1	*	*	9.7	El Paso	10	22	32	22	9	4	1	*	*	11.3
FLA. Jacksonville	10	33	35	18	3	*	*	*	*	8.9	Reno	52	20	13	10	4	1	*	*	*	5.9	Ft. Worth	4	14	34	34	10	3	*	*	*	12.5
Miami	14	30	34	20	2	*	*	*	*	8.8	N. J. Newark	11	25	34	24	5	1	*	*	*	9.8	Galveston	4	13	39	33	10	2	1	*	*	12.5
Orlando	18	28	32	17	4	*	*	*	*	8.6	N. MEX. Albuquerque	17	36	26	13	5	2	*	*	*	8.6	Houston	6	18	36	28	10	2	*	*	*	11.8
Tallahassee	33	36	23	7	*	*	*	*	*	6.1	N. Y. Albany	23	24	27	21	4	1	*	*	*	8.6	Laredo	6	15	32	34	12	1	*	*	*	12.3
Tampa	9	31	40	16	2	*	*	*	*	8.8	Binghamton	11	23	35	25	5	1	*	*	*	10.0	Lubbock	4	11	33	34	13	5	1	*	*	13.6
West Palm Beach	9	22	36	27	6	1	*	*	*	10.5	Buffalo	5	17	34	27	13	3	1	*	*	12.4	Midland	9	22	38	26	4	1	*	*	*	10.1
GA. Atlanta	13	24	36	21	6	1	*	*	*	9.7	New York (Kennedy)	6	17	35	28	10	3	*	*	*	12.0	San Antonio	18	23	32	22	4	1	*	*	*	9.3
Augusta	36	29	25	9	1	*	*	*	*	6.3	New York (La Guardia)	6	15	30	31	12	4	1	*	*	12.9	Waco	3	14	36	35	10	2	*	*	*	12.5
Macon	10	26	46	16	2	*	*	*	*	8.9	Rochester	8	22	34	25	9	2	1	*	*	11.2	Wichita Falls	5	22	41	27	5	1	*	*	*	10.5
Savannah	12	34	37	14	3	*	*	*	*	8.4	Syracuse	14	27	30	23	5	1	*	*	*	9.7	UTAH, Salt Lake City	12	33	36	14	4	1	*	*	*	8.7
HAWAII, Hilo	7	34	43	15	2	*	*	*	*	8.7	N. C. Charlotte	20	32	31	14	2	*	*	*	7.9	VT. Burlington	24	24	28	22	2	*	*	*	*	8.3	
Honolulu	9	17	27	32	12	2	*	*	*	12.1	Greensboro	20	32	31	14	2	*	*	*	8.0	VA. Norfolk	14	23	30	25	6	1	*	*	*	10.2	
IDAHO, Boise	15	30	32	18	4	1	*	*	*	8.9	Raleigh	18	33	34	14	2	*	*	*	7.7	Richmond	14	37	36	11	1	*	*	*	*	7.8	
ILL. Chicago (O'Hare)	8	22	33	27	8	2	*	*	*	11.2	Winston-Salem	19	22	33	21	4	1	*	*	*	9.0	Roanoke	31	22	23	17	5	2	*	*	*	8.3
Chicago (Midway)	7	26	36	25	5	1	*	*	*	10.2	N. DAK. Bismarck	14	20	27	24	12	3	1	*	*	11.2	WASH. Seattle-Tacoma AP	13	16	35	26	8	2	*	*	*	10.7
Moline	14	23	32	24	7	2	*	*	*	10.0	Fargo	4	13	28	31	15	7	2	*	*	14.4	Spokane	17	38	27	14	3	1	*	*	*	8.1
Springfield	7	22	28	27	12	3	1	*	*	12.0	OHIO, Akron-Canton	7	25	35	26	5	1	*	*	*	10.4	W. VA. Charleston	29	37	25	8	1	*	*	*	*	6.2
IND. Evansville	19	23	32	21	5	1	*	*	*	9.1	Cincinnati	11	27	36	22	4	1	*	*	*	9.6	WIS. Green Bay	8	22	32	26	10	2	*	*	*	11.2
Fort Wayne	9	23	33	25	8	2	*	*	*	10.9	Cleveland	7	18	35	29	9	2	*	*	*	11.6	Madison	15	22	30	23	7	2	*	*	*	10.1
Indianapolis	9	22	34	26	7	2	*	*	*	10.8	Columbus	26	23	29	18	4	1	*	*	*	8.2	Milwaukee	8	17	31	30	11	3	1	*	*	12.1
South Bend	7	21	35	30	7	1	*	*	*	10.9	Dayton	8	25	36	23	6	2	*	*	*	10.3	WYO. Casper	8	16	27	27	13	7	2	*	*	13.3
IOWA, Des Moines	3	17	38	29	10	3	1	*	*	12.1	Youngstown	7	26	36	24	6	1	*	*	*	10.3	PACIFIC, Wake Island	1	6	27	48	17	2	*	*	*	14.6
Sioux City	10	20	31	25	10	4	1	*	*	11.7	OKLA. Oklahoma City	2	11	34	34	13	6	1	*	*	14.0	P. R. San Juan	15	28	27	25	4	*	*	*	*	9.1

Source: Climatology of the United States Series 82; Decennial Census of the United States Climate -- Summary of Hourly Observations, 1951-60 (Table B)

SURFACE WIND ROSES, MONTHLY AND ANNUAL; RES



" Pocket Guide to Chemical Hazards "

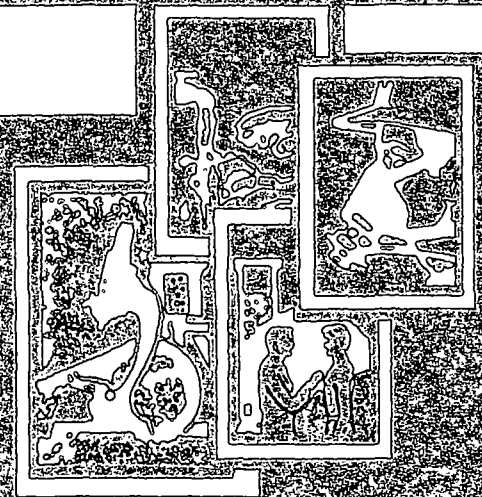
USDHHS. 1994. Pocket Guide to Chemical Hazards. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, June. pgs 14-15.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
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NIOSH

POCKET GUIDE TO

CHEMICAL HAZARDS



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

CDC
CENTERS FOR DISEASE CONTROL
AND PREVENTION

Chemical name, structure/formula, CAS and RTECS Nos., and DOT ID and guide Nos.	Synonyms, trade names, and conversion factors	Exposure limits (TWA unless noted otherwise)	IDLH	Physical description	Chemical and physical properties		Incompatibilities and reactivities	Measurement method (See Table 1)
					MW, BP, SOL Fl.P., IP, Sp, Gr, flammability	VP, FRZ UEL, LEL		
4-Aminodiphenyl $C_6H_5C_6H_4NH_2$ 92-67-1 DU8925000	4-Aminobiphenyl, p-Aminobiphenyl, p-Aminodiphenyl, 4-Phenylaniline	NIOSH Ca See Appendix A OSHA[1910.1011] See Appendix B	Ca [N.D.]	Colorless crystals with a floral odor. [Note: Turns purple on contact with air.]	MW: 169.2 BP: 576°F Sol: Slight Fl.P.: ? IP: ? Sp.Gr: 1.16 Combustible Solid, but must be preheated before ignition possible.	VP(227°F): 1 mm MLT: 127°F UEL: ? LEL: ?	Oxidized by air	Filter/ Si gel; 2-Propanol; GC/FID; II(4) [P&CAM #269]
2-Aminopyridine $NH_2C_5H_4N$ 504-29-0 US1575000	α -Aminopyridine, α -Pyridylamine	NIOSH/OSHA 0.5 ppm (2 mg/m ³)	5 ppm	White powder, leaflets, or crystals with a characteristic odor.	MW: 94.1 BP: 411°F Sol: >100% Fl.P: 154°F IP: 8.00 eV	VP(77°F): 0.8 mm MLT: 137°F UEL: ? LEL: ?	Strong oxidizers	Tenax GC(2); Thermal desorp; GC/FID; III [#S158]
2671 55	1 ppm = 3.91 mg/m ³				Sp.Gr: ? Combustible Solid			
Amitrole $C_2H_4N_4$ 61-82-5 XZ3850000	Aminotriazole; 3-Aminotriazole; 2-Amino-1,3,4-triazole; 3-Amino-1,2,4-triazole	NIOSH Ca 0.2 mg/m ³ See Appendix A OSHA† none	Ca [N.D.]	Colorless to white, crystalline powder. [herbicide] [Note: Odorless when pure.]	MW: 84.1 BP: ? Sol(77°F): 28% Fl.P: NA IP: ? Sp.Gr: 1.14 Noncombustible Solid, but may be dissolved in flammable liquids.	VP: <0.000008 mm MLT: 318°F UEL: NA LEL: NA	Light (decomposes), strong oxidizers [Note: Corrosive to iron, aluminum & copper.]	Filter; none; Grav; III [#0500, Nuisance Dust (total)]
Ammonia NH_3 7664-41-7 BO0875000 1005 15 (anhydrous) 2672 60 (12-44% soln.) 2073 15 (>44% soln.)	Anhydrous ammonia, Aqua ammonia, Aqueous ammonia [Note: Often used in an aqueous solution.] 1 ppm = 0.71 mg/m ³	NIOSH 25 ppm (18 mg/m ³) ST 35 ppm (27 mg/m ³) OSHA† 50 ppm (35 mg/m ³)	300 ppm	Colorless gas with a pungent, suffo- cating odor. [Note: Shipped as a liquefied compressed gas. Easily liquefied under pressure.]	MW: 17.0 BP: -28°F Sol: 34% Fl.P: NA (Gas) IP: 10.18 eV RGasD: 0.60 [Note: Although NH_3 does not meet the DOT definition of a Flammable Gas (for labeling purposes), it should be treated as one.]	VP: 8.5 atm FRZ: -108°F UEL: 28% LEL: 15%	Strong oxidizers, acids, halogens, salts of silver & zinc [Note: Corrosive to copper & galvanized surfaces.]	Passive sampler; none; IC; III [#6701]

Personal protection and sanitation (See Table 3)		Recommendations for respirator selection — maximum concentration for use (MUC) (See Table 4)	Health hazards				
			Route	Symptoms (See Table 5)	First aid (See Table 6)	Target organs (See Table 5)	
Skin:	Prevent skin contact	NIOSH	Inh	Head, dizz; leth, dysp;	Eye:	Irr immed	Bladder, skin [bladder cancer]
Eyes:	Prevent eye contact	✖: SCBAF:PD,PP/SAF:PD,PP:ASCBA	Abs	ataxia, weak; methemo;	Skin:	Soap wash immed	
Wash skin:	When contam/Daily	Escape: HiEF/SCBAE	Ing	urinary burning; acute	Breath:	Resp support	
Remove:	When wet or contam		Con	hemorrhagic cystitis; [carc]	Swallow:	Medical attention immed	
Change:	Daily						
Provide:	Eyewash, Quick drench						
[4-Aminodiphenyl]							
Skin:	Prevent skin contact	NIOSH/OSHA	Inh	Irrit eyes, nose, throat;	Eye:	Irr immed	CNS, resp sys
Eyes:	Prevent eye contact	5 ppm: SA*/SCBAF	Abs	head, dizz; excitement;	Skin:	Water flush immed	
Wash skin:	When contam	§: SCBAF:PD,PP/SAF:PD,PP:ASCBA	Ing	nau; high BP; resp	Breath:	Resp support	
Remove:	When wet or contam	Escape: GMFOVHiE/SCBAE	Con	distress; weak; convuls;	Swallow:	Medical attention immed	
Change:	Daily			stupor			
Provide:	Quick drench						
[2-Aminopyridine]							
Skin:	Prevent skin contact	NIOSH	Inh	Irrit eyes, skin; dysp,	Eye:	Irr immed	Eyes, skin, thyroid [in animals: liver, thyroid & pituitary gland tumors]
Eyes:	Prevent eye contact	✖: SCBAF:PD,PP/SAF:PD,PP:ASCBA	Ing	musc spasms, ataxia, anor,	Skin:	Water wash immed	
Wash skin:	Daily	Escape: GMFOVHiE/SCBAE	Con	salv, incr body temperature;	Breath:	Resp support	
Remove:	When wet or contam			lass, skin dryness, depres (thyroid func suppression)	Swallow:	Medical attention immed	
Change:	Daily						
Provide:	Eyewash, Quick drench						
[Amitrole]							
Skin:	Prevent skin contact	NIOSH	Inh	Irrit eyes, nose, throat;	Eye:	Irr immed (soln/liq)	Eyes, skin, resp sys
Eyes:	Prevent eye contact	250 ppm: CCRS*/SA*	Ing	dysp, bronspas, chest	Skin:	Water flush immed	
Wash skin:	When contam (soln)	300 ppm: SA:CF*/PAPRS*/CCRFs/ GMFS/SCBAF/SAF	(soln)	pain; pulm edema; pink		(soln/liq)	
Remove:	When wet or contam (soln)	§: SCBAF:PD,PP/SAF:PD,PP:ASCBA	Con	frothy sputum; skin burns,	Breath:	Resp support	
Change:	N.R.	Escape: GMFS/SCBAE	(soln/liq)	vesic; liq: frostbite	Swallow:	Medical attention immed (soln)	
Provide:	Eyewash (>10%), Quick drench (>10%)						
[Ammonia]							

" Health Consultation "

USDHHS. 1998. Health Consultation. U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation, August 27. pgs 1-4.

SMOKEY MOUNTAIN SMELTERS
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U.S. EPA # TN0002318277
TSDF #47-559

SEP 10 1998
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Health Consultation

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, KNOX COUNTY, TENNESSEE

CERCLIS NO. TND098071061

AUGUST 27, 1998

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Public Health Service

Agency for Toxic Substances and Disease Registry

Division of Health Assessment and Consultation

Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR TOLL FREE at
1-800-447-1544

or

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HEALTH CONSULTATION

SMOKEY MOUNTAIN SMELTERS

KNOXVILLE, KNOX COUNTY, TENNESSEE

CERCLIS NO. TND098071061

Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

The U.S. Environmental Protection Agency (EPA) - Region IV asked the Agency for Toxic Substances and Disease Registry (ATSDR) to assess the public health impact of environmental contamination at the Smokey Mountain Smelters site. This health consultation will be based on data and information contained in the Preliminary Assessment Report prepared by the Tennessee Department of Environment and Conservation (TDEC). Further site evaluation is warranted as additional information becomes available.

The site is located in Knox County, just outside the city limits of Knoxville, Tennessee. The owner formerly operated a secondary aluminum smelter on the property. The property covers approximately 13 acres, and contains a large industrial process building that housed the rotary and casting furnaces. The area surrounding the facility is described as being medium commercial and dense residential.

Wastes from smelting operations were dumped or buried on site. The wastes included bag house dust and slag from the rotary furnaces. The disposal area is unfenced and access is unrestricted. EPA staff observed footprints and discarded candy wrappers on site, indicating that children are trespassing on the property.

In October 1997, representatives of the State of Tennessee, Division of Superfund, conducted a Preliminary Assessment of the site. Officials collected four waste samples from indoor and outdoor waste piles and dust from the bag house and analyzed for metals and extractable organic compounds. The maximum concentrations of metals detected in the waste samples were: aluminum - 135,000 parts per million (ppm), copper - 42,900 ppm, and lead - 291 ppm. Polyaromatic hydrocarbons (PAHs) were detected in bag house dust at concentrations ranging from 143 parts per billion (ppb) [phenanthrene] to 2,170 ppb [indeno(1,2,3-cd)pyrene].

One sediment sample was collected 20 yards downgradient of a waste pile. The concentrations of metals and PAHs in this sample were not at levels of health concern.

Using passive dosimeter tubes, officials detected ammonia concentrations of 15 ppm at the surface of a disturbed waste pile and at 20 ppm inside an auger hole in a waste pile. Ammonia was not detected (detection limit not specified) at the surface of other waste piles or above an on-site lagoon.

DISCUSSION

Waste materials containing aluminum, copper, and PAHs were disposed on-site. Since access to the site is unrestricted, trespassers could be exposed to contaminants in these wastes. Based on the reported data, such intermittent exposures would not pose a health hazard. Furthermore, the concentrations of contaminants detected in on-site wastes would not pose a health hazard for adults who worked on the site and were exposed under an occupational exposure scenario.

The potential impact of site-related contamination on groundwater quality in the area was not investigated. This is of potential concern because: (1) An estimated 1,000 cubic yards of wastes were buried on site or disposed of on the surface. (2) Karst geology in the area would allow contaminants to easily migrate to the groundwater. (3) Groundwater wells in the area are as shallow as 35 feet below ground surface. TDEC staff reported that some residents may obtain water from private wells, even though the area is supplied by a public water system.

The potential impact of site-related contamination on ambient air quality was not investigated. Possible air contaminants of concern include metals, total suspended particulates, and ammonia. Off-site migration of air contaminants could impact nearby residents; an estimated 207 people live within 1/4 mile of the site. Monitoring results obtained with passive dosimeter tubes indicated that ammonia is emanating from some of the waste piles. In addition, State officials reported smelling ammonia during on-site inspections. This suggests that ammonia is present in on-site ambient air at concentrations within the human odor threshold range of 0.039 to 58.2 ppm.

The physical structure of the main building is unstable, and a portion of the north wall has collapsed. Therefore, the condition of the building poses a physical hazard to trespassers.

CONCLUSIONS

- (1) Based on limited data, the concentrations of contaminants detected in on-site, solid waste materials do not pose a public health hazard under current site conditions.
- (2) Information is not available to assess the potential impact of site-related contamination on groundwater and ambient air quality in the area.
- (3) The unstable condition of the industrial process building poses a physical hazard to trespassers.

RECOMMENDATIONS

- (1) Further characterize the extent and nature of on-site and possible off-site contamination.
- (2) Investigate the potential impact of contamination on groundwater quality in the area. This should include a survey of private well use in the area.
- (3) Investigate the potential impact of contamination on ambient air quality in the area.
- (4) Restrict public access to the industrial process building.

Kenneth G. Orloff

Kenneth Orloff, Ph.D., DABT

Concurrence: *[Signature]*

" Graphical Exposure Modeling System (GEMS) Database "

U. S. EPA. 1990. Graphical Exposure Modeling System (GEMS) Database. U.S. Environmental Protection Agency. Compiled from U.S. Bureau of the Census Data (1990).

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

Smokey Mountain Smelters, 47-559
1990 Census Data - Block Level

LAT: 0355511

LONG: 0835548

KM	0.00- 0.4	0.4- 0.8	0.8- 1.6	1.6- 3.2	3.2- 4.8	4.8- 6.4	TOTAL
RING	207	831	2995	5515	25906	28954	64408
TOTALS							

" Envirofacts Query Results "

U. S. EPA. 1998. Envirofacts Query Results, Zip Code 37920. U.S. Environmental Protection Agency. July 9.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

Envirofacts Query Results

Zipcode entered: 37920

Query executed on: 09-JUL-98

Results are based on data extracted on 15-JUN-98

Total Number of facilities retrieved are: 76

LIST OF EPA-REGULATED FACILITIES IN ENVIROFACTS

EPA ID FACILITY NAME ADDRESS	Permitted Discharges to Water?	Toxic Releases Reported?	Hazardous Waste Handler?	Active or Archived Superfund Report?	Air Releases Reported?
TN0001078435 AD GRAPHICS INC RRT 23 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND987776234 AMERICAN LIMESTONE CO INC 2209 BLOUNT AVE KNOXVILLE, TN 379201956	NO	NO	YES	NO	YES
TN0001043652 APPROACH 13-30 CORP 1005 MARYVILLE PK KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0002320224 BERRY ROAD DUMP BERRY RD KNOXVILLE, TN 37920	NO	NO	NO	YES	NO
TND982104432 BIG ORANGE CLEANERS S GATE SHOP CTR KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078427 BRADEN TRUCKS INC 935 CHESTER RD SE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND027382472 BULLET BOATS INC RT 29 OLD SEVIERVILLE PK KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001723303 CANDORO MARBLE CO 681 MARYVILLE PIKE KNOXVILLE, TN 37920	YES	NO	NO	NO	NO
TND987783479 CARGO REMANUFACTURED PRODUCTS INC 2547 SCOTTIS PIKE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO

TND982104499 CHAPMAN HWY CLEANERS 5822 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078617 COMPUTER CONCEPTS CORP 3731 MARTIN MILL PK KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078591 CONSIN MFG CO 4011 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078518 CONST MATERIALS LAB 2204 ATCHLEY ST SE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078492 COOKS TRAVEL TRAILERS INC 8105 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND987781408 CORNER CABINET SHOP 1600 ISLAND HOME AVE KNOXVILLE, TN 37920	NO	NO	NO	YES	NO
TN0001921477 CRUZE ROAD DUMP CRUZE RD KNOXVILLE, TN 37920	NO	NO	NO	YES	NO
TND034692632 DIXIE BARREL & DRUM CO INC 2120 JONES ST KNOXVILLE, TN 37920	NO	NO	YES	NO	YES
TND074892233 EAST TENNESSEE BAPTIST HOSPITAL 137 BLOUNT AVE KNOXVILLE, TN 37290	NO	NO	YES	NO	NO
TN0002104750 ELECTRO CHEMICAL ENGINEERING, INC 1324-1326 N BROADWAY 1618 ISL KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND049472152 FI-SHOCK INC 5360 NATIONAL DR KNOXVILLE, TN 37920	NO	NO	NO	NO	YES
TN0001078377 FINN EQUIPMENT CO 2651 SCOTTISH PIKE SW KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078542 HELEN ROSS MC NABB CTR INC 1520 CHEROKEE TRAIL KNOXVILLE, TN 37920	NO	NO	YES	NO	NO

TN0001078534 HILLCREST SOUTH NURSING FAC 1758 HILLWOOD DR KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001826320 K & N PAINTING CO 1190 MARYVILLE PIKE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001723345 K-MART STORE 3360 CHAPMAN HWY KNOXVILLE, TN 37920	YES	NO	NO	NO	NO
TN0001043637 KC LETTERING CO 4920 MORELAND HGTS LANE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078559 KELLER INC 2336 SYLVANIA AVE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078500 KIMBERLIN HEIGHTS IND INC RT 19 HODGES FERRY RD KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078567 KNOX RAG SVC 2516 SEVIER AVE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078575 KNOX SWEEPING SVC 204 AILSIE DR KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND987777935 KNOXVILLE GLOVE CORP 444 BLOUNT AVE KNOXVILLE, TN 37901	NO	NO	YES	NO	NO
TND980848089 KNOXVILLE ONE HOUR CLEANERS NO. 1 3106 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078443 LUTTRELL DENTAL LAB 229 1/2 HAWTHORNE AVE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078484 MAIN W J CO MALONEY RD KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078583 MALOY CROWN & BRIDGE LAB 134 MARYVILLE PK KNOXVILLE, TN 37920	NO	NO	YES	NO	NO

TN0001078450 MC LEMORE PRINTING CO 2708 MARTIN MILL PIKE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078609 MID STATE MATERIALS CO 3107 MC CLURE LN KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND987791092 NATIONAL STANDARD CO 5427 NATIONAL DR KNOXVILLE, TN 37920	NO	YES	YES	NO	NO
TN0001078526 NEWMAN LARRY PRINTING CO 6202 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND058664152 PATENT PLASTICS INC 638 MARYVILLE PIKE SW KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND987782638 PHILLIPS PETROLEUM CO STA #27562 3925 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND987776291 PLASTI-LINE INC 1901 JONES ST KNOXVILLE, TN 379201817	NO	NO	YES	NO	NO
TN0001723329 PLATEAU FUELS AREA 1 RT 3 GINN RD KNOXVILLE, TN 37920	YES	NO	NO	NO	NO
TND987791233 RECYCLED PRINTERS INK 7324 HODGES FERRY RD KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001043660 RESORT MARKETING INC ABNER CRUZE LANE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078633 RIGHT OF WAY SVC CO INC 6541 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001078419 ROSS TRUCKING JOHN HALL RD W KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001723352 RULE AMOCO 8125 CHAPMAN HWY KNOX COUNTY, TN 37920	YES	NO	NO	NO	NO

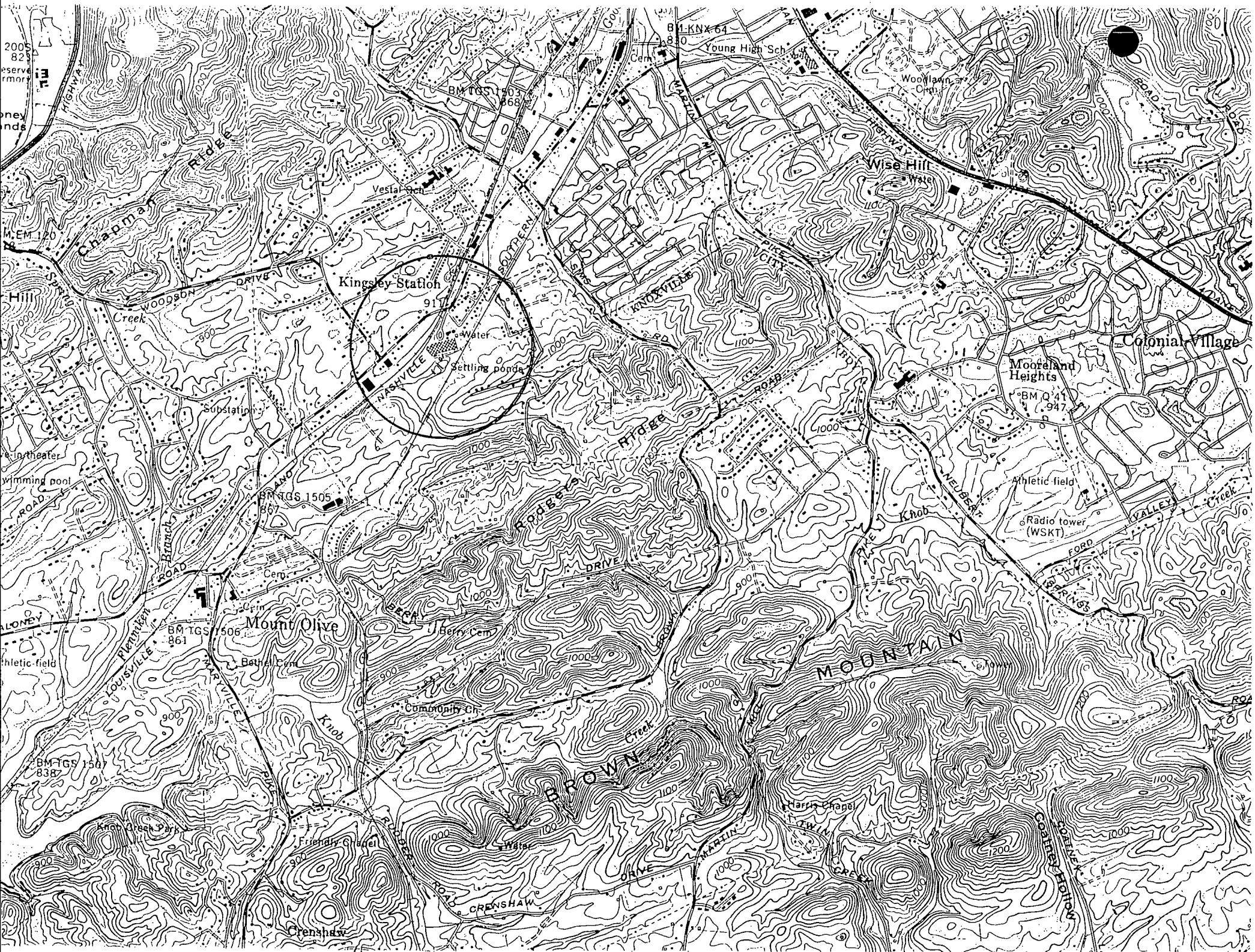
TND981021306 SANITARY LUANDRY & DRY CLEANING CO INC 3914 CHAPMAN HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND063184972 SCREEN ART INC 1630 MARYVILLE PIKE KNOXVILLE, TN 37920	NO	NO	YES	YES	NO
TN0001078393 SMITHS WELDING & IRON WKS INC 706 REDWINE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0002318277 SMOKEY MOUNTAIN SMELTERS 1508 MARYVILLE PIKE KNOXVILLE, TN 37920	NO	NO	NO	YES	NO
TND098071061 SMOKEY MOUNTAIN SMELTERS INC 1455 MARYVILLE PIKE KNOXVILLE, TN 37920	NO	NO	NO	NO	YES
TND987771870 SO STATES ASPHALT 1808 JONES ST KNOXVILLE, TN 37920	NO	NO	NO	NO	YES
TN0001078641 TENNESSEE EMULSIONS INC 3107 MC CLURE LANE KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND074903550 TEXACO INC 701 LANGFORD AVE KNOXVILLE, TN 37920	YES	NO	YES	YES	YES
TND980602007 UNION OIL CO 1720 ISLAND HOME AVE KNOXVILLE, TN 37901	NO	NO	YES	NO	YES
TN0001078468 UNION PRINTERS INC 1107 PHILLIPS ST KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TND982172173 UNIVERSITY OF TENN MEMORIAL 1924 ALCOA HWY KNOXVILLE, TN 37920	NO	NO	YES	NO	YES
TND003377603 VOLUNTEER ASPHALT 3111 MCCLURE LANE KNOXVILLE, TN 37920	NO	NO	YES	NO	YES
TN0001723295 VOLUNTEER PROCESSING CO 1801 JONES ST KNOXVILLE, TN 37920	YES	NO	NO	NO	NO

TN0001043645 WEED-TROL CO 121 STONE RD KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TN0001723311 WILLIAMS LIME KNOXVILLE ISLAND HOME PIKE KNOXVILLE, TN 37920	YES	NO	NO	NO	NO
TND987768637 WITHERSPOON DAVID INC 901 OLD MARYVILLE PIKE KNOXVILLE, TN 37920	NO	NO	NO	YES	NO
TND980848311 WITHERSPOON LDFL OLD MARYVILLE PIKE KNOXVILLE, TN 37920	NO	NO	NO	YES	NO
TN0001078658 WOODS & SON 6620 CHAPMAN KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
ADAMS COMPONENTS INC PO BOX 9118 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
B & R AUTOMOTIVE DIESEL MCH SP PO BOX 9370 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
CAM & ENGINE SERVICE INC PO BOX 9189 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
DALEN PRODUCTS INC PO BOX 11707 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
DUPLI-SERVICE INC PO BOX 2671 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
EDDIES DENTAL LAB PO BOX 1811 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
MOTORSPORT GRAPHICS PO BOX 9433 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
SOUTHERN COFFIN & CASKET CO* PO BOX 9176 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
SOUTHERN FABRIC FINSHG CO. INC. PO BOX 835 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO
TENN TEX CHEMICAL COMPANY INC PO BOX 9236 KNOXVILLE, TN 37920	NO	NO	YES	NO	NO

"Knoxville 1966 Topographic Map "

U.S. Geological Survey, 7.5 minute series Topographic
Quadrangle Maps of Tennessee: Knoxville (147-NW)
1966, scale 1:24,000.

SMOKEY MOUNTAIN SMELTERS
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U.S. EPA # TN0002318277
TSDF #47-559



" Air Pollution - Its Origin and Control "

Wark K. And Warner C. 1981. Air Pollution - Its Origin and Control, Second Edition. New York: Harper & Row. Pp: 97 and 477.

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AIR POLLUTION

Its Origin and Control

Kenneth Wark
and Cecil F. Warner



Second Edition

to meet these requirements. If values of K can be determined for various malodorous effluents, analytical instruments can be used to measure odor intensity directly and establish the degree of control required. These measurements can be made in the field, thus precluding the need to transport samples and to make allowances for fatigue and adaptation of the human olfactory sense.

An instrument for measuring the intensity of diesel exhaust odor has been developed by Arthur D. Little, Inc. [7]. An odor panel was employed in the determination of the chemical species of diesel exhaust which contribute to the characteristic burnt-oily odor. After those species were identified, values of the constants in an equation similar to the Weber-Fechner equation relating odor intensity to chemical concentration of the odorous species were determined. The instrument measures the concentration of the hydrocarbon species which are responsible for the diesel exhaust odor and by means of the intensity-concentration equation relates the measured concentration to an intensity readout scale.

11-5 ODOR THRESHOLD VALUES

As has been mentioned previously, the concentrations of odorous substances that can be detected by the human nose vary by many orders of magnitude. Examples of odor threshold concentrations for selected substances are presented in Table 11-1. An indication of the range of odor threshold concentrations of similar species is presented in Table 11-2 [8]. A more extensive list of the threshold concentrations of 100 petrochemicals using sensory methods has been published by Hellman and Small [9]. The magnitude of the odor control problem can be seen when we compare detection of acetone versus

Table 11-1 ODOR THRESHOLDS IN AIR

CHEMICAL	ODOR THRESHOLD (ppm)	ODOR DESCRIPTION
Acetic acid	1.0	Sour
Acetone	100.0	Chemically sweet
Amine monomethyl	0.021	Fishy, pungent
Amine trimethyl	0.0021	Fishy, pungent
Ammonia	46.8	Pungent
Carbon disulfide	0.21	Vegetable sulfide
Chlorine	0.314	Bleach, pungent
Diphenyl sulfide	0.0047	Burnt, rubbery
Formaldehyde	1.0	Hay or strawlike
Hydrogen sulfide	0.00047	Eggy
Methanol	100.	Sweet
Methylene chloride	214.	
Phenol	0.047	Medicinal

SOURCE: G. Leonardos, D. Kendall, and N. Bernard. "Odor Threshold Determinations of 53 Odorant Chemicals." *J. Air Pollu. Control Assoc.* 19, no. 2 (1969): 91-95.

" Directory of Tennessee Manufacturers "

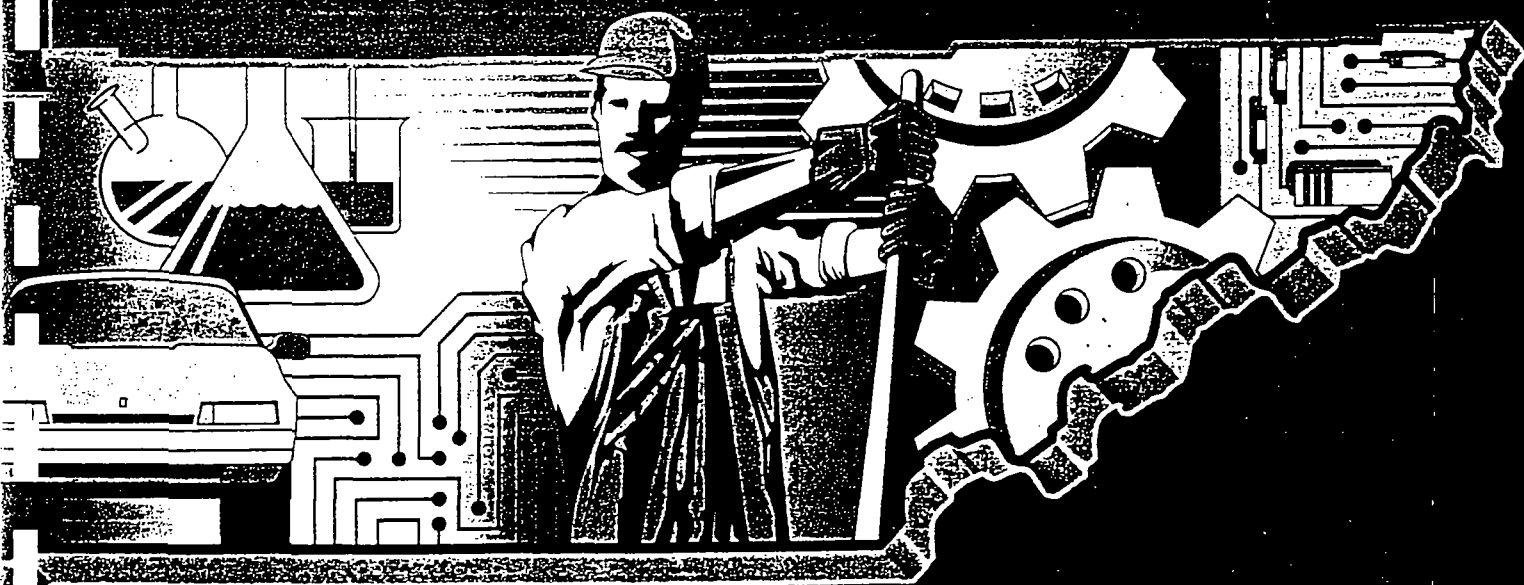
White, J. 1995. Directory of Tennessee Manufacturers. M. Lee Smith Publishers and Printers LLC.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559

1995

DIRECTORY OF

TENNESSEE MANUFACTURERS



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Ft. Oglethorpe (Catoosa)
Phone 706-866-9885
Page B-2
- Signal Mountain Cement Co.**
Chattanooga (Hamilton)
Phone 615-886-0800
Page B-115
- Signal Mtn. Cement Co.**
Jasper (Marion)
Phone 615-942-2636
Page B-172
- Signal Plating Div. of Metal Plate**
Cleveland (Bradley)
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Memphis (Shelby)
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- Skelton Lumber Co. Inc.**
Waynesboro (Wayne)
Phone 615-722-3281
Page B-285
- Skill Printing**
Memphis (Shelby)
Phone 901-774-1804
Page B-249
- Skullbone Printing Service**
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- Skyline Manufacturing Corp.**
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Crossville (Cumberland)
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- Slim EZ-Mr. America Mfg. Inc.**
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Kingsport (Sullivan)
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- Sloan Monument Co. Inc.**
Lebanon (Wilson)
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- Smith Metal Works**
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- Smith Metals Co. Inc.**
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- Smith Welding & Iron Works Inc.**
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- Smithfield Industries Inc.**
Clarksville (Montgomery)
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- SmithKline Beecham Pharmaceuticals**
Bristol (Sullivan)
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- Smithville Mfg. Inc.**
Smithville (DeKalb)
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Page B-74
- Smithville Review**
Smithville (DeKalb)
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- Smithville Tool & Die**
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- Smoky Mountain Secrets**
Alcoa (Blount)
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- Smoky Mtn. Country Hams**
Madisonville (Monroe)
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- Smoky Mtn. Vending-Sally's Salads**
Sevierville (Sevier)
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Elizabethton (Carter)
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Johnson City (Washington)
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Greeneville (Greene)
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- Snapvent Co.**
Knoxville (Knox)
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- Snell's Limbs & Braces Inc.**
Jackson (Madison)
Phone 901-423-3121
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- Snyder Signs Inc.**
Johnson City (Washington)
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- Snyder's Inc.**
Gray (Washington)
Phone 615-239-5671
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- Sofix Corp.**
Chattanooga (Hamilton)
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- SOLA/Hevi Duty**
Celina (Clay)
Phone 615-243-3113
Page B-40
- Solar-10 Inc.**
Newport (Cocke)
Phone 615-623-1417
Page B-42
- Solene Industrial Lubricants**
Knoxville (Knox)
Phone 615-521-6444
Page B-154
- Soltech Thermacoustics Div.**
Cleveland (Bradley)
Phone 615-472-7186
Page B-30
- Solution Fibers Inc.**
La Fayette (Walker)
Phone 706-638-5678
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- Somerville Mills Mfg. Co.**
Somerville (Fayette)
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Chattanooga (Hamilton)
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- South & South Inc.**
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- South Knoxville Monument Co.**
Knoxville (Knox)
Phone 615-522-0625
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TN-Knox County-Knoxville

Geographic Section

Bill Quillen, VP/Administration
Charles Wheeler, Engineering Mgr.
John Allen, Plant Mgr.
Phyllis Gifford, Purchasing Mgr.
Conveyors 3535
Market: National; Workers: 60
Plant Size: 35,000 Sq. Ft.
Annual Sales: \$5,000,000
Computer: Hewlett Packard - 7311
Stainless Steel 3312
Aluminum 3353
Electric Motors 3621
Conveyor Belts 3496

SMITH WELDING & IRON WORKS INC.

706 Redwine St
Knoxville TN 37920-1968
Phone: 615-573-4211
Established 1958
Milas Smith, President
Sam Beeler, Vice President
Steel Fabrication 3493
Ornamental Iron 3446
Market: Local; Workers: 3*
Plant Size: 3,500 Sq. Ft.
Annual Sales: \$100,000
Stainless Steel 3312
Cast Iron 3321

SMOKEY MOUNTAIN SMELTERS INC.

PO Box 2704
Knoxville TN 37901-2704
1455 Maryville Pike
Knoxville TN 37920-3954
Phone: 615-573-4473
FAX: 615-573-9546
Established 1979
Dan Johnson, Owner/President
Tammy Key, Office Mgr.
Jim Burgess, Plant Mgr.
Aluminum Ingots 3334
Market: National; Workers: 19*
Plant Size: 69,000 Sq. Ft.
Computer: IBM - PC
Aluminum Dross 3334

SNAPVENT CO.

147 W Baxter Ave
Knoxville TN 37917-6402
Phone: 615-523-6784
FAX: 615-523-9272
Established 1941
C.E. Easterday, Mgr./Owner
Michael Easterday, Office Mgr.
Aircraft Window Ventilators 3089
Plastic Parts 3089
Market: Int'l; Workers: 5
Plant Size: 5,000 Sq. Ft.
Acrylic Sheet 3081
Acetate Sheet 3081
Polycarbonate Sheet 3081

SOLENE INDUSTRIAL LUBRICANTS

3315 Riverside Dr
Knoxville TN 37914-6430
Phone: 615-521-6444
FAX: 615-522-7615
Established 1988
Mike Wall, Facility Mgr.
Industrial Lubricants 2992
Market: Multistate; Workers: 5
Plant Size: 10,000 Sq. Ft.
Computer: Gateway - 2000
Base Oil 2911
Cutting & Lubricating Additives 2911
RELS LUBRICANTS NORTH AMERICA
5 N Stiles St
Linden NJ 07036
Phone: 908-862-9300

SOUTH KNOXVILLE MONUMENT CO.

3041 Sutherland Ave
Knoxville TN 37919-4560
Phone: 615-522-0625
Established 1936
Gary Epps, Owner
Monuments 3281
Market: Local; Workers: 1
Marble 1411
Granite 1411

SOUTH'S FINEST CHOCOLATE FACTORY

8078 Kingston Pike Ste 101
Knoxville TN 37919-5501
Phone: 615-690-5454
FAX: 615-531-8976
Established 1983
William Douglass, President
Chocolate 2064
Market: Multistate; Workers: 10
Plant Size: 800 Sq. Ft.
Sugar 2062
Cocoa 2066
Milk 0241

SOUTHEASTERN MACHINE REBUILDERS INC.

8424 Asheville Hwy
Knoxville TN 37924-4103
Phone: 615-933-0087
FAX: 615-933-9401
Established 1982
J.T. Chapman, Owner
Rebuild Production Machines 3599
Market: Multistate; Workers: 19*
Plant Size: 47,000 Sq. Ft.
Computer: IBM Compatible
Cold Rolled Steel 3316
Aluminum 3334
Brass 3351

SOUTHERN ALLEGHENY WOOD PRODUCTS

7322 Hodges Ferry Rd
Knoxville TN 37920-9732
Phone: 615-579-9547
FAX: 615-577-4207
Established 1993
John McCann, Operations Mgr.
Door Thresholds 2431
Market: National; Workers: 15
Computer: Samsung
Lumber 2421
Aluminum Extrusion 3354
Paint 2851
Screws 3452

SOUTHERN ARMATURE WORKS INC.

1721 Potter St
Knoxville TN 37917-4835
Phone: 615-522-8639
FAX: 615-522-5808
Established 1979
Troy Perrin, President
James Perrin, Vice President
Rebuilt Electric Motors 3621
Market: Multistate; Workers: 12
Plant Size: 3,150 Sq. Ft.
Annual Sales: \$750,000
Computer: IBM
Wire 3315
Bearings 3562

SOUTHERN CAST STONE INC.

PO Box 1669
Knoxville TN 37901-1669
2100 Sutherland Ave
Knoxville TN 37919-2348
Phone: 615-524-3351
FAX: 615-523-6113
Established 1934
Nelson Russell, Vice President
Concrete Block 3271
Structural Concrete Products 3272
Market: Multistate; Workers: 60
Plant Size: 35,000 Sq. Ft.
Computer: IBM
Sand 1442
Gravel 1422
Cement 3241

SOUTHERN CLUTCH & SUPPLY INC.

PO Box 6224
Knoxville TN 37914-0224
6713 Rutledge Pike
Knoxville TN 37924-2730
Phone: 800-525-6011
Established 1949
Y.C. Hudson, Owner
Clutch Assemblies 3711
Market: Multistate; Workers: 5

Plant Size: 5,000 Sq. Ft.
Computer: Tandy
Clutch Facings 3292
Release & Tilot Bearings 3714

SOUTHERN FOUNDRY SUPPLY INC.

PO Box 1827
Knoxville TN 37901-1827
2826 N Central
Knoxville TN 37917-5115
Phone: 615-524-2791
FAX: 615-523-6526
Established 1973
Jeff Stratton, General Mgr.
Ferrous Metals 5093
Nonferrous Metals 5093
Market: Int'l; Workers: 40
Plant Size: 100,000 Sq. Ft.
Computer: Unisys
Scrap Metals 5093
R&SMC CORP.
PO Box 6216
Chattanooga TN 37401
Phone: 615-756-6070

SOUTHERN STATES ASPHALT CO. INC. DIV., ASHLAND OIL INC.

1808 Jones St
Knoxville TN 37920-1816
Phone: 615-577-5151
FAX: 615-579-4176
Established 1988
John Hall, CEO
Gordon Cassity, Mgr. Sales & Ops.
Jeff Day, Plant Mgr.
Asphalt 2911
Heavy Fuel Oil 2911
Market: Multistate; Workers: 10
Plant Size: 10,000 Sq. Ft.
Computer: IBM
Liquid Asphalt 2911
Sand 1442
ASHLAND OIL INC.
PO Box 391
Ashland KY 41114
Phone: 606-329-3333

SPECIALTY PRINTING CO.

3705 Sutherland Ave
Knoxville TN 37919-4338
Phone: 615-584-3891
Established 1953
Earl Day, President
Printing 2752
Market: Multistate; Workers: 3
Plant Size: 2,000 Sq. Ft.
Annual Sales: \$200,000
Paper 2621
Ink 2893

SPINLAB UTILITY INSTRUMENTATION

10330 Technology Dr
Knoxville TN 37932-2570*
Phone: 615-671-2484
FAX: 615-671-2488
Established 1990
N.J. Ackermann Jr., Vice President*
Utility Testing Equipment 3825
Market: Int'l; Workers: 6*
Plant Size: 2,200 Sq. Ft.
Current Probes 3845

SPORTS BELLE INC.

PO Box 50243
Knoxville TN 37950-0243
6723 Pleasant Ridge Rd
Knoxville TN 37921-1021
Phone: 615-938-2063
FAX: 615-947-4466
Established 1974
Jesse Lee, President
John Sewell, Operations Dir.
Gene Shular, Plant Mgr.
Athletic Apparel, Men's 2329
Athletic Apparel, Women's 2339
Market: National; Workers: 140
Plant Size: 20,000 Sq. Ft.
Computer: Digital
Nylon Fabric 2221
Polyester Fabric 2221
Lycra 2221

STALEY GRANITE & MARBLE INC.

PO Box 9126
Knoxville TN 37940-0126
2805 Cinder Ln
Knoxville TN 37914-9526
Phone: 615-521-6890
FAX: 615-524-0951
Established 1972
Brian Staley, President*
Marble Fireplaces 3281
Marble Window Sills 3281
Marble Tabletops & Tile 3281
Marble & Granite Products 3281
Market: Int'l; Workers: 12
Plant Size: 30,000 Sq. Ft.
Computer: IBM
Marble 3281
Granite 3281

STEEL PLATE FABRICATORS

PO Box 11112
Knoxville TN 37939-1112
3703 Papermill Rd
Knoxville TN 37909-1521
Phone: 615-522-1700
FAX: 615-673-8360
Established 1945
John E. Turner, President
Jill Hudson, Controller
Mike Russell, Data Pro. Mgr.
Jill R. Davis, Personnel Mgr.
Steel Plate Fabrication 3443
Sheet Metal Job Shop 3444
Market: Multistate; Workers: 48
Plant Size: 65,000 Sq. Ft.
Computer: Compaq
Steel Sheets 3316
Steel Plates 3316
Steel Shapes 3316

STERLING WINDOW SYSTEMS

6705 Pleasant Ridge Rd
Knoxville TN 37921-1021
Phone: 615-938-0422
FAX: 615-947-2750
Established 1976
Sterling Lance, President
Mike Lance, Vice President
Therm. Replacement Windows 3442
Vinyl Replacement Windows 3089
Insulating Glass 3211
Market: Multistate; Workers: 24*
Plant Size: 24,000 Sq. Ft.
Annual Sales: \$2,000,000
Computer: IBM - PC
Glass 3211
Aluminum Extrusions 3355
Vinyl Extrusions 3089

STONECRAFT INC.

PO Box 22069
Knoxville TN 37933-0069
10524 Lexington Dr
Knoxville TN 37932-3211
Phone: 615-966-3900
FAX: 615-966-3930
Ricciardi Jones, CEO
Ellen Jane Jones, Secretary/Treasurer
Sam Letsinger, Controller
Dorothy Swaggerty, Export Mgr.
Vera Whaley, Mkt.-Sales Mgr.
Dorothy Swaggerty, Office Mgr.
Dorothy Swaggerty, Personnel Mgr.
Glenn Owens, Plant Mgr.
Glenn Owens, Purchasing Mgr.
Joe Terry, Traffic Mgr.
Marble, Granite Countertops 3281
Stone Floors 1741
Stone Fireplaces 1743
Stone Walls 1741
Market: Multistate; Workers: 14
Plant Size: 5,000 Sq. Ft.
Annual Sales: \$900,000
Computer: IBM
Marble 1411
Granite 1411
Slate 1411
Limestone 1411

STUBLEY-KNOX LITHO CO.

1528 Island Home Ave
Knoxville TN 37920-1813
Phone: 615-523-4567
FAX: 615-573-2220

Ductile Iron Castings 3321
Steel Castings 3325
Fabricated Metal Products 3499
Metal Work 3449

IKG BORDEN
Nashville (Davidson Co.) TN
Market: Int'l; Workers: 140
Phone: 615-242-4262
Aluminum Grating 3446
Fiberglass Gratings 3089
Steel Grating 3325
Deck Spans 3448

PRECISION CASTINGS OF TENNESSEE INC.
Gallatin (Sumner Co.) TN
Market: Int'l; Workers: 60
Phone: 615-451-9080
Precision Steel Castings 3325
Steel Investment Castings 3324

QUAD INDUSTRIES INC.
Bradford (Gibson Co.) TN
Market: Multistate; Workers: 20
Phone: 901-742-3903
Cast Bearings 3325
Copper Bearings 3366
Plain Bearings 3562
Screw Machine Products 3451

ROYAL BRASS & HOSE
Knoxville (Knox Co.) TN
Market: National; Workers: 45
Phone: 615-558-0224
Hydraulic Hoses 3492
Brass Fittings 3432
Steel Adapters 3325
Fasteners (Nuts, Bolts) 3452

SPECIALTY ALLOYS CORP.
Galloway (Fayette Co.) TN
Market: National; Workers: 30
Phone: 901-867-2126
Alloy Briquettes 3325
Silicon-Manganese Briquettes 3339

TENNESSEE INVESTMENT CASTINGS CO. INC.
Bristol (Sullivan Co.) TN
Market: National; Workers: 80
Phone: 615-968-4252
Precision Steel Castings 3325

3334 Primary Production of Aluminum

ALUMINUM CO. OF AMERICA
Alcoa (Blount Co.) TN
Market: Int'l; Workers: 2100
Phone: 615-977-2011
Aluminum 3334
Recycle (Smelt) Aluminum 3341

HUTCHERSON METALS INC.
Halls (Lauderdale Co.) TN
Market: National; Workers: 82
Phone: 901-836-9435
Aluminum Sows 3334
Recycle Scrap Iron 5093

SMOKEY MOUNTAIN SMELTERS INC.
Knoxville (Knox Co.) TN
Market: National; Workers: 19
Phone: 615-573-4473
Aluminum Ingots 3334

TENNESSEE ALUMINUM PROCESSORS
Mount Pleasant (Maury Co.) TN
Market: State; Workers: 110
Phone: 615-379-5836
Aluminum Processing 3334

3339 Primary Smelting & Refining of Nonferrous Metals, Except Copper & Aluminum

ALLIED METAL RECOVERY CO.
Oliver Springs (Roane Co.) TN
Market: State; Workers: 2
Phone: 615-435-0894
Silver Refinery 3339

D.M.S. REFINING INC.
Dandridge (Jefferson Co.) TN
Market: National; Workers: 13
Phone: 615-397-9447
Refine Precious Metals 3339

GENERAL SMELTING & REFINING INC.
College Grove (Williamson Co.) TN
Market: Multistate; Workers: 40
Phone: 615-368-7125
Refine Metal 3339
Lead Products 3341

MANUFACTURING SCIENCES CORP.
Oak Ridge (Anderson Co.) TN
Market: Int'l; Workers: 28
Phone: 615-481-0455
Beryllium 3339
Rolling of Depleted Uranium 3356

REFINED METALS CORP.
Memphis (Shelby Co.) TN
Market: Multistate; Workers: 150
Phone: 901-775-3770
Lead Refining 3339
Antimonial Lead Alloys 3341

SAVAGE ZINC INC.
Gordonsville (Smith Co.) TN
Market: Local; Workers: 250
Phone: 615-683-6411
Zinc Ore Mining 1031
Zinc Concentrate 3339

SPECIALTY ALLOYS CORP.
Galloway (Fayette Co.) TN
Market: National; Workers: 30
Phone: 901-867-2126
Alloy Briquettes 3325
Silicon-Manganese Briquettes 3339

3341 Secondary Smelting & Refining of Nonferrous Metals

ALLOY EXCHANGE
Newbern (Dyer Co.) TN
Market: Int'l; Workers: 5
Phone: 901-627-3251
Metal Processing 3341

ALUMINUM CO. OF AMERICA
Alcoa (Blount Co.) TN
Market: Int'l; Workers: 2100
Phone: 615-977-2011
Aluminum 3334
Recycle (Smelt) Aluminum 3341

CHATTANOOGA RECYCLED FIBER
Chattanooga (Hamilton Co.) TN
Market: Local; Workers: 10
Phone: 615-267-0097
Paperboard 2631
Aluminum 3341

F. PERLMAN & CO. INC.
Memphis (Shelby Co.) TN
Market: Int'l; Workers: 39
Phone: 901-526-7651
Scrap Steel Processing 5093
Nonferrous Metal 3341

GENERAL SMELTING & REFINING INC.
College Grove (Williamson Co.) TN
Market: Multistate; Workers: 40
Phone: 615-368-7125
Refine Metal 3339
Lead Products 3341

IMCO RECYCLING INC.
Rockwood (Roane Co.) TN
Market: Int'l; Workers: 130
Phone: 615-354-3626
Recycle Aluminum Cans 5093
Scrap Aluminum Ingots 3341

KNOX METALS CORP.
Knoxville (Knox Co.) TN
Market: National; Workers: 45
Phone: 615-637-4353
Scrap Iron 5093
Nonferrous Metals 3341

METAL RESOURCES INC.
Loudon (Loudon Co.) TN
Market: National; Workers: 64
Phone: 615-458-2007
Secondary Smelting of Aluminum 3341

PGP SILVER PROCESSING
Coalfield (Morgan Co.) TN
Market: National; Workers: 18
Phone: 615-435-1704
Recovery of Silver from Film 3341

REFINED METALS CORP.
Memphis (Shelby Co.) TN
Market: Multistate; Workers: 150
Phone: 901-775-3770
Lead Refining 3339
Antimonial Lead Alloys 3341

SIGNAL ALLOYS CO.
Chattanooga (Hamilton Co.) TN
Market: National; Workers: 14
Phone: 615-624-5051
Zinc Alloys 3341

SMELTER SERVICE CORP.
Mount Pleasant (Maury Co.) TN
Market: National; Workers: 40
Phone: 615-379-7765
Aluminum Smelting 3341

SOUTHERN FOUNDRY SUPPLY INC.
Chattanooga (Hamilton Co.) TN
Market: National; Workers: 155
Phone: 615-756-6070
Recycled Metal 3341

STEINER-LIFF IRON & METAL CO.
Nashville (Davidson Co.) TN
Market: Int'l; Workers: 150
Phone: 615-271-3300
Scrap Metal 5093
Scrap Iron & Metal Processing 3341

STURDY LITE INC.
Bristol (Sullivan Co.) TN
Market: National; Workers: 10
Phone: 615-968-7021
Aluminum Extrusions 3341

TECHNICAL PLATING & RUBBER INC.
Watertown (Wilson Co.) TN
Market: National; Workers: 15
Phone: 615-237-9767
Plastisol Coating 3479
Electroplating & Plating 3471
Polyurethane Castings/Coating 3089
Silver/Tin/Electroless Nickel 3356
Zinc Plating 3341

TWIN CITY IRON & METAL CO. INC.
Bristol (Sullivan Co.) TN
Market: Multistate; Workers: 23
Phone: 703-466-2022
Metal Processing 3341

UNITED STATES BRONZE POWDERS INC. - ROYAL DIV.
Maryville (Blount Co.) TN
Market: Int'l; Workers: 18
Phone: 615-982-8096
Copper Smelting 3341

WABASH ALLOYS INC.
Dickson (Dickson Co.) TN
Market: Multistate; Workers: 70
Phone: 615-446-0600
Aluminum Foundry 3365
Aluminum Smelting 3341

3351 Rolling, Drawing, & Extruding of Copper

APACHE GROUNDING
Lebanon (Wilson Co.) TN
Market: National; Workers: 28
Phone: 615-449-1962
Galvanized Grounding Rods 3312
Copper Grounding Rods 3351

HUDSON INTERNATIONAL CONDUCTORS
Trenton (Dade Co.) GA
Market: National; Workers: 60
Phone: 706-657-7541
Magnet Wire 3351
Thin Wall Tubing 3599

TATE FABRICATING CO. INC.
White House (Robertson Co.) TN
Market: State; Workers: 100
Phone: 615-672-4909
Fabricated Structural Steel 3441
Brass 3351

W. BOMAS MANUFACTURING CO. INC.
Nolensville (Williamson Co.) TN
Market: National; Workers: 4
Phone: 615-776-2840
Copper & Brass Gift Items 3999
Aluminum Gift Items 3999
Brass Railings 3351
Architectural Brassware 3351

WESTINGHOUSE ELECTRIC CORP., ELECTRICAL MATERIALS DIV.
Abingdon (Washington Co.) VA
Market: National; Workers: 400
Phone: 703-676-9100
Copper Wire 3351

WOLVERINE TUBE INC.
Ardmore (Giles Co.) TN
Market: National; Workers: 75
Phone: 615-427-2034
Copper Tubing 3351

3353 Aluminum Sheet, Plate, & Foil

CRESSONA ALUMINUM CO.
Elizabethton (Carter Co.) TN
Market: Int'l; Workers: 245
Phone: 615-543-3561
Extruded Aluminum Pipe & Tube 3354
Aluminum Extrusions 3354
Extruded Mini-Plate 3353

DAVIDSON MANUFACTURING CORP.
Smyrna (Rutherford Co.) TN
Market: National; Workers: 100
Phone: 615-459-6094
Wood Ladders 2499
Aluminum 3353
Fiberglass 2221

NORANDAL USA INC.
Huntingdon (Carroll Co.) TN
Market: Int'l; Workers: 235
Phone: 901-986-5011
Aluminum Foil 3353
Aluminum Sheet 3353

" 1997 Directory of Tennessee Manufacturers "

White, J. 1997. Directory of Tennessee Manufacturers. M. Lee Smith Publishers and Printers LLC.

SMOKEY MOUNTAIN SMELTERS
KNOXVILLE, TENNESSEE 37920
U.S. EPA # TN0002318277
TSDF #47-559



1997 DIRECTORY



OF **TENNESSEE**

MANUFACTURERS

Published by M. Lee Smith Publishers LLC



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Skaggs Iron Works Inc.
Memphis (Shelby)
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Skill Printing
Memphis (Shelby)
Phone: 901-774-1804
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Skullbone Printing Service
Bradford (Gibson)
Phone: 901-742-2450
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Skyline Coal Co.
Dunlap (Sequatchie)
Phone: 423-949-4161
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Skyline Manufacturing Corp.
Nashville (Davidson)
Phone: 615-321-3330
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Slatten Cedar Sawmill
Quebec (White)
Phone: 615-657-5116
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Sledge Craft
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Phone: 615-898-1223
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Slender You Financial Inc.
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Slip-Not Belting Corp.
Kingsport (Sullivan)
Phone: 423-246-8141
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Sloan Monument Co. Inc.
Lebanon (Wilson)
Phone: 615-444-2224
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SM Athletics Inc.
Knoxville (Knox)
Phone: 423-966-3434
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Smalley Mfg. Co. Inc.
Knoxville (Knox)
Phone: 423-966-5868
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Smartt Cabinets
Chattanooga (Hamilton)
Phone: 423-266-8157
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Smelter Service Corp.
Mount Pleasant (Maury)
Phone: 615-379-7765
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Smith & Nephew ENT
Bartlett (Shelby)
Phone: 901-373-0200
Page: B-222

Smith & Nephew Orthopedics
Memphis (Shelby)
Phone: 901-396-2121
Page: B-248

Smith County Coatings Inc.
Gordonsville (Smith)
Phone: 615-683-3300
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Smith Metals Co. Inc.
Selmer (McNairy)
Phone: 901-645-6302
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Smith Welding & Iron Works Inc.
Knoxville (Knox)
Phone: 423-573-4211
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Smith's Sheet Metal Works
Maury City (Crockett)
Phone: 901-656-2098
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Smithfield Manufacturing Inc.
Clarksville (Montgomery)
Phone: 615-552-4327
Page: B-189

SmithKline Beecham Pharmaceuticals
Bristol (Sullivan)
Phone: 423-652-3100
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Smithville Mfg. Inc.
Smithville (DeKalb)
Phone: 615-597-4045
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Smithville Review
Smithville (DeKalb)
Phone: 615-597-5485
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Smithville Tool & Die
Smithville (DeKalb)
Phone: 615-597-6030
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SMK Machine & Fabrication Inc.
Ringgold (Catoosa)
Phone: 706-935-9105
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Smoky Mountain Industries
Cleveland (Bradley)
Phone: 423-478-3892
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Smoky Mountain Secrets
Alcoa (Blount)
Phone: 423-970-3217
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Smoky Mountain Winery Inc.
Gatlinburg (Sevier)
Phone: 423-436-7505
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Smoky Mtn. Country Hams
Madisonville (Monroe)
Phone: 423-442-5003
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Smoky Mtn. Vending-Sally's Salads
Sevierville (Sevier)
Phone: 423-453-7158
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Snap-On Tools Corp.
Elizabethton (Carter)
Phone: 423-543-5771
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Johnson City (Washington)
Phone: 423-929-1193
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Snapp Printing Co.
Greeneville (Greene)
Phone: 423-638-4542
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Snapvent Co.
Knoxville (Knox)
Phone: 423-523-6784
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Snell's Limbs & Braces Inc.
Jackson (Madison)
Phone: 901-423-3121
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Snyder Signs Inc.
Johnson City (Washington)
Phone: 423-282-6221
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Snyder's Inc.
Gray (Washington)
Phone: 423-239-5671
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Sofix Corp.
Chattanooga (Hamilton)
Phone: 423-624-3500
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SOLA/Hevi Duty
Celina (Clay)
Phone: 615-243-3113
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Solar-10 Inc.
Newport (Cocke)
Phone: 423-623-1417
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Solomon's Printed Circuits Inc.
Murfreesboro (Rutherford)
Phone: 615-898-0355
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Solution Fibers Inc.
La Fayette (Walker)
Phone: 706-638-5678
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Sonoco Engraph
Memphis (Shelby)
Phone: 901-527-9400
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Sonoco Flexible Packaging
Morristown (Hamblen)
Phone: 423-585-5850
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Sonoco Products
Memphis (Shelby)
Phone: 901-365-9666
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Sonoco Products Co. Inc.
Chattanooga (Hamilton)
Phone: 423-698-6985
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Jackson (Madison)
Phone: 901-424-3740
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Memphis (Shelby)
Phone: 901-942-2492
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Nashville (Davidson)
Phone: 615-262-3837
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Newport (Cocke)
Phone: 423-623-8611
Page: B-41

Sossner Steel Stamps
Elizabethton (Carter)
Phone: 423-543-4001
Page: B-36

Sound Impressions
Nashville (Davidson)
Phone: 615-777-3535
Page: B-67

South & South Inc.
Columbia (Maury)
Phone: 615-388-4732
Page: B-176

South Knoxville Monument Co.
Knoxville (Knox)
Phone: 423-522-0625
Page: B-152

South's Finest Chocolate Factory
Knoxville (Knox)
Phone: 423-690-5454
Page: B-152

Southdown-Knoxville Cement Plant
Knoxville (Knox)
Phone: 423-541-5500
Page: B-152

Southeast Associated Machine Inc.
Ooltewah (Hamilton)
Phone: 423-238-5336
Page: B-119

Southeast Industries Inc.
Johnson City (Washington)
Phone: 423-928-8441
Page: B-31

Southeast Mat Co. Inc.
Crossville (Cumberland)
Phone: 615-484-1222
Page: B-48

Southeastern Apparel Finishing Inc.
Johnson City (Washington)
Phone: 423-929-8115
Page: B-31

Southeastern Color Graphics Inc.
Johnson City (Washington)
Phone: 423-282-9111
Page: B-31

Southeastern Industrial Services Inc.
Cleveland (Bradley)
Phone: 423-479-8030
Page: B-30

Southeastern Machine Rebuilders Inc.
Knoxville (Knox)
Phone: 423-933-0087
Page: B-152

Southeastern Pant
Centerville (Hickman)
Phone: 615-729-9545
Page: B-132

Southeastern Shirt Corp.
Mount Pleasant (Maury)
Phone: 615-379-3231
Page: B-177

Southeastern Stair & Millwork Co.
Cleveland (Bradley)
Phone: 423-479-1188
Page: B-30

Southeastern Technology Inc.
Murfreesboro (Rutherford)
Phone: 615-890-1700
Page: B-215

Southeastern Tool & Die
Greenbrier (Robertson)
Phone: 615-643-4591
Page: B-206

Southeastern Unipole
Mount Pleasant (Maury)
Phone: 615-379-3125
Page: B-177

Southerland Inc.
Nashville (Davidson)
Phone: 615-226-9650
Page: B-67

Southern Advertising Co.
Memphis (Shelby)
Phone: 901-362-2070
Page: B-248

Southern Alloys & Metals Corp.
Rockwood (Roane)
Phone: 423-354-2790
Page: B-206

Southern Armature Works Inc.
Knoxville (Knox)
Phone: 423-522-8639
Page: B-152

Southern Auto Electric Co.
Memphis (Shelby)
Phone: 901-396-4811
Page: B-248

Southern Automation Sales & Service
Knoxville (Knox)
Phone: 423-690-8488
Page: B-152

Southern Bloomer Mfg. Co.
Bristol (Sullivan)
Phone: 423-878-6660
Page: B-7

SMITH WELDING & IRON WORKS INC.

706 Redwine St
Knoxville TN 37920-1968
Phone: 423-573-4211
Established 1958
Sam Beeler, President*
Steel Fabrication 3493
Ornamental Iron 3446
Market: Local; Workers: 4*
Plant Size: 3,500 Sq. Ft.
Annual Sales: \$100,000
Stainless Steel 3312
Cast Iron 3321

SNAPVENT CO.

147 W Baxter Ave
Knoxville TN 37917-6402
Phone: 423-523-6784
FAX: 423-523-9272
Established 1941
C.E. Easterday, Mgr./Owner
Michael Easterday, Office Mgr.
Aircraft Window Ventilators 3089
Plastic Parts 3089
Market: Int'l; Workers: 5
Plant Size: 5,000 Sq. Ft.
Acrylic Sheet 3081
Acetate Sheet 3081
Polycarbonate Sheet 3081

SOUTH KNOXVILLE MONUMENT CO.

3041 Sutherland Ave
Knoxville TN 37919-4560
Phone: 423-522-0625
Established 1936
Mary Epps, Owner
Monuments 3281
Market: Local; Workers: 1
Marble 1411
Granite 1411

SOUTH'S FINEST CHOCOLATE FACTORY

8078 Kingston Pike Ste 101
Knoxville TN 37919-5501
Phone: 423-690-5454
FAX: 423-531-8976
Established 1983
William Douglass, President
Chocolate 2064
Market: Multistate; Workers: 10
Plant Size: 800 Sq. Ft.
Sugar 2062
Cocoa 2066
Milk 0241

SOUTHDOWN-KNOXVILLE CEMENT PLANT

PO Box 14009
Knoxville TN 37914-1009
26212 Cement Plant Rd
Knoxville TN 37924-2721
Phone: 423-541-5500*
FAX: 423-541-5595
Established 1927
Larry Hoffis, Plant Mgr.
Herman Wurth, Controller
John Crandford, Mkt.-Sales Mgr.
Portland Cement 3241
Market: Multistate; Workers: 160
Computer: Compaq
Sand 1442
Gravel 1422
SOUTHDOWN INC.
1200 Smith St
Houston TX 77002
Phone: 713-650-6200

SOUTHEASTERN MACHINE REBUILDERS INC.

8424 Asheville Hwy
Knoxville TN 37924-4103
Phone: 423-933-0087
FAX: 423-933-9401
Established 1982
J.T. Chapman, Owner
Reconditioned Production Machines 3599
Market: Multistate; Workers: 10*

Plant Size: 47,000 Sq. Ft.
Computer: IBM Compatible
Cold Rolled Steel 3316
Aluminum 3334
Brass 3351

SOUTHERN ARMATURE WORKS INC.

1721 Potter St
Knoxville TN 37917-4835
Phone: 423-522-8639
FAX: 423-522-5808
Established 1979
Troy Perrin, President
James Perrin, Vice President
Rebuilt Electric Motors 3621
Market: Multistate; Workers: 9
Plant Size: 3,150 Sq. Ft.
Annual Sales: \$750,000
Computer: IBM
Wire 3315
Bearings 3562

SOUTHERN AUTOMATION SALES & SERVICE

PO Box 30753
Knoxville TN 37930-0753
20201 Perimeter Pk
Knoxville TN 37922
Phone: 423-690-8488
FAX: 423-691-7109
Established 1985
Bill Logan, Owner
Pat Logan, Manager*
Pat Logan, Controller
Don Fleischer, Engineering Mgr.*
Pat Logan, Personnel Mgr.*
Barbara Miller, Purchasing Mgr.
Linda Meadows, Traffic Mgr.*
Industrial Computers 3575
Monitors 3575
Market: Int'l; Workers: 17*
Plant Size: 15,000 Sq. Ft.
Preformed Steel Comp. 3312
Electronic Components 3679
Electronic Switches 3643

SOUTHERN CLUTCH & SUPPLY INC.

PO Box 6224
Knoxville TN 37914-0224
26713 Rutledge Pike
Knoxville TN 37924-2730
Phone: 800-525-6011
Established 1949
Y.C. Hudson, Owner
Clutch Assemblies 3711
Market: Multistate; Workers: 5
Plant Size: 5,000 Sq. Ft.
Computer: Tandy
Clutch Facings 3292
Release & Pilot Bearings 3714

SOUTHERN FOUNDRY SUPPLY INC.

PO Box 1827
Knoxville TN 37901-1827
2826 N Central
Knoxville TN 37917-5115
Phone: 423-524-2791
FAX: 423-523-6526
Established 1973
Jeff Stratton, General Mgr.
Ferrous Metals 5093
Nonferrous Metals 5093
Market: Int'l; Workers: 48*
Plant Size: 100,000 Sq. Ft.
Computer: Unisys
Scrap Metals 5093
RSMC CORP.
PO Box 6216
Chattanooga TN 37401
Phone: 615-756-6070

SOUTHERN STATES ASPHALT CO. INC. DIV. ASHLAND INC.

1808 Jones St
Knoxville TN 37920-1816
Phone: 423-577-5151
FAX: 423-579-4176
Established 1988
John Hall, CEO
Gordon Cassidy, Mgr Sales & Ops
Asphalt 2911
Heavy Fuel Oil 2911
Market: Multistate; Workers: 10
Plant Size: 10,000 Sq. Ft.
Computer: IBM

Liquid Asphalt 2911
Sand 1442
ASHLAND INC.
PO Box 391
Ashland KY 41114
Phone: 606-329-3333

SPECIALTY PRINTING CO.

1326 N Broadway St
Knoxville TN 37917-6501
Phone: 423-673-8002
FAX: 423-673-0114
Established 1953
Earl Day, President
Printing 2752
Market: Multistate; Workers: 2
Plant Size: 2,000 Sq. Ft.
Annual Sales: \$200,000
Paper 2621
Ink 2893

SPINLAB UTILITY INSTRUMENTATION INC.

3110 Henson Rd Ste A1
Knoxville TN 37921*
Phone: 423-212-9881*
FAX: 423-212-9886*
Established 1990
J.L. Ellison, President
Utility Testing Equipment 3825
Market: Int'l; Workers: 6
Plant Size: 2,500 Sq. Ft.
Current Probes 3845

SPORTS BELLE INC.

PO Box 50243
Knoxville TN 37950-0243
26723 Pleasant Ridge Rd
Knoxville TN 37921-1021
Phone: 423-938-2063
FAX: 423-947-4466
Established 1974
Jesse Lee, President
Terri Ayob, Operations Dir
Gene Shular, Plant Mgr.
Athletic Apparel, Men's 2329
Athletic Apparel, Women's 2339
Market: National; Workers: 140
Plant Size: 20,000 Sq. Ft.
Computer: Digital
Nylon Fabric 2221
Polyester Fabric 2221
Lycra 2221

STALEY GRANITE & MARBLE INC.

PO Box 9126
Knoxville TN 37940-0126
2805 Cinder Ln
Knoxville TN 37914-9526
Phone: 423-521-6890
FAX: 423-524-0951
Established 1972
Brian Staley, President
Marble Fireplaces 3281
Marble Window Sills 3281
Marble Tabletops 3281
Marble Tile 3281
Granite Products 3281
Market: Int'l; Workers: 12
Plant Size: 30,000 Sq. Ft.
Computer: IBM
Marble 3281
Granite 3281

STEEL PLATE FABRICATORS

PO Box 11112
Knoxville TN 37939-1112
23703 Papermill Rd
Knoxville TN 37909-1521
Phone: 423-522-1700
FAX: 423-673-8360
Established 1945
John E. Turner, President
Mike Russell, VP*
Jill Hudson, Controller
Mike Russell, Data Pro. Mgr.
Jill Hudson, Personnel Mgr.*
Steel Plate Fabrication 3443
Sheet Metal Job Shop 3444
Market: Multistate; Workers: 48
Plant Size: 65,000 Sq. Ft.
Computer: Compaq
Steel Sheets 3316
Steel Plates 3316
Steel Shapes 3316

STERLING WINDOW SYSTEMS

6705 Pleasant Ridge Rd
Knoxville TN 37921-1021
Phone: 423-938-0422
FAX: 423-947-2750
Established 1976
Sterling Lance, President
Mike Lance, Vice President
Thermal Replacement Windows
Vinyl Replacement Windows
Insulating Glass
Market: Multistate; Workers: 2
Plant Size: 24,000 Sq. Ft.
Annual Sales: \$2,000,000
Computer: IBM - PC
Glass
Aluminum Extrusions
Vinyl Extrusions

STUBLEY-KNOX LITHO CO.

1528 Island Home Ave
Knoxville TN 37920-1813
Phone: 423-523-4567
FAX: 423-573-2220
Established 1900
J.H. Ingram, Owner
James G. Ingram, Production
Four-Color Offset Printing
Four-Color Brochures
Four-Color Booklets
Market: Multistate; Workers: 5
Plant Size: 8,500 Sq. Ft.
Annual Sales: \$500,000
Paper
Ink

SUN COAL CO.

PO Box 10388
Knoxville TN 37939-0388
21111 Northshore Dr Ste N-3
Knoxville TN 37919
Phone: 423-558-0300
FAX: 423-558-3280
Email: LISA_A_COBBLE@SUNOIL.com*
M.H.R. Dings, President*
Dale N. Walker, Sr VP Operat
Earl H. Humber, Controller
Tony Grasa, Export Mgr.*
Jack D. Lovely, Mkt.-Sales Mgr.
Karen E. Free, Personnel Mgr.
Coal
Market: Int'l; Workers: 740*

SUNSHINE INDUSTRIES

PO Box 2041
Knoxville TN 37901-2041
23000 N Central
Knoxville TN 37917-5117
Phone: 423-546-9431
FAX: 423-546-5536
Established 1972
Vicki Johnson, Exec Director
Chris Griffin, Adv.-PR Mgr.*
Jo Anderson, Plant Mgr.
Kathy Sunderland, Purchasing
Credenzas
Metal Bookcases
Market: National; Workers: 160
Plant Size: 30,000 Sq. Ft.
Annual Sales: \$2,800,000*
Computer: IBM - 36
Hot Rolled Steel Sheet
Steel Tubing
Cold Rolled Steel
Hardware
KNOX COUNTY ASSOCIATION
FOR RETARDED CITIZENS
3000 N Central Ave
Knoxville TN 37917
Phone: 615-524-1311

SUPERIOR ICE CO. - CRYSTAL CUBES ICE CO. LTD.

2727 Middlebrook Pike
Knoxville TN 37921-5662
Phone: 423-522-1362
Established 1973
J.R. Thatcher, Owner
Crushed Packaged Ice
Market: Local; Workers: 4
Plant Size: 4,000 Sq. Ft.
Water

Various Castings	3322
Nonferrous Castings	3364
Heavy Machinery	3599
CNC Production Machinery	3542
Customized Machinery	3599
3324 Steel Investment Foundries	
ACCU-CAST	
Chattanooga (Hamilton Co.) TN	
Market: National; Workers: 100	
Phone: 423-622-4344	
Steel Investment Castings	3324
INDEPENDENT STEEL CASTINGS CO. INC.	
Oliver Branch (DeSoto Co.) MS	
Market: National; Workers: 65	
Phone: 601-895-4003	
Steel Investment Castings	3324
PRECISION CASTINGS OF TENNESSEE INC.	
Gallatin (Sumner Co.) TN	
Market: Int'l; Workers: 60	
Phone: 615-451-9080	
Precision Steel Castings	3325
Steel Investment Castings	3324
QUALITY GOLF CASTINGS INC.	
Burpinesville (Hawkins Co.) TN	
Market: National; Workers: 12	
Phone: 423-345-4945	
Golf Club Heads	3324
3325 Steel Foundries, NEC	
ACHESON FOUNDRY & MACHINE WORKS INC.	
Chattanooga (Hamilton Co.) TN	
Market: National; Workers: 22	
Phone: 423-266-4863	
Gray Iron Castings	3321
Ductile Iron Castings	3321
Steel Castings	3325
CLARKSVILLE FOUNDRY INC.	
Clarksville (Montgomery Co.) TN	
Market: National; Workers: 45	
Phone: 615-647-1538	
Gray Iron Castings	3321
Ductile Iron Castings	3321
Steel Castings	3325
Fabricated Metal Products	3499
Metal Work	3449
BIG BORDEN	
Nashville (Davidson Co.) TN	
Market: Int'l; Workers: 140	
Phone: 615-242-4262	
Aluminum Grating	3446
Fiberglass Gratings	3089
Steel Grating	3325
Deck Spans	3448
MAGOTTEAUX CORP.	
Pulaski (Giles Co.) TN	
Market: Int'l; Workers: 309	
Phone: 615-363-7471	
Steel Grinding Balls	3399
Steel Liner Plates	3443
Alloy Castings	3325
PRECISION CASTINGS OF TENNESSEE INC.	
Gallatin (Sumner Co.) TN	
Market: Int'l; Workers: 60	
Phone: 615-451-9080	
Precision Steel Castings	3325
Steel Investment Castings	3324
QUAD INDUSTRIES INC.	
Bradford (Gibson Co.) TN	
Market: Multistate; Workers: 20	
Phone: 901-742-3903	
Cut Bearings	3325
Copper Bearings	3366
Plain Bearings	3562
Crane Machine Products	3451

ROYAL BRASS & HOSE	
Knoxville (Knox Co.) TN	
Market: National; Workers: 45	
Phone: 423-558-0224	
Hydraulic Hoses	3492
Brass Fittings	3432
Steel Adapters	3325
Nuts	3452
Bolts	3452
SPECIALTY ALLOYS CORP.	
Gallaway (Fayette Co.) TN	
Market: National; Workers: 30	
Phone: 901-867-2126	
Alloy Briquettes	3325
Silicon-Manganese Briquettes	3339
TENNESSEE INVESTMENT CASTINGS CO. INC.	
Bristol (Sullivan Co.) TN	
Market: National; Workers: 80	
Phone: 423-968-4252	
Precision Steel Castings	3325

3334 Primary Production of Aluminum

ALUMINUM CO. OF AMERICA	
Alcoa (Blount Co.) TN	
Market: Int'l; Workers: 2100	
Phone: 423-977-2011	
Aluminum	3334
Recycle (Smelt) Aluminum	3341
HUTCHERSON METALS INC.	
Halls (Lauderdale Co.) TN	
Market: National; Workers: 82	
Phone: 901-836-9435	
Aluminum Sows	3334
Recycle Scrap Iron	5093
TENNESSEE ALUMINUM PROCESSORS	
Mount Pleasant (Maury Co.) TN	
Market: National; Workers: 140	
Phone: 615-379-5836	
Aluminum Processing	3334

3339 Primary Smelting & Refining of Nonferrous Metals, Except Copper & Aluminum

ALLIED METAL RECOVERY CO.	
Oliver Springs (Roane Co.) TN	
Market: State; Workers: 2	
Phone: 423-435-0894	
Silver Refinery	3339
D.M.S. REFINING INC.	
Dandridge (Jefferson Co.) TN	
Market: National; Workers: 13	
Phone: 423-397-9447	
Refine Precious Metals	3339
GENERAL SMELTING & REFINING INC.	
College Grove (Williamson Co.) TN	
Market: Multistate; Workers: 45	
Phone: 615-368-7125	
Refined Metal	3339
Lead Products	3341
NORTH AMERICAN OXIDE INC.	
Clarksville (Montgomery Co.) TN	
Market: Multistate; Workers: 48	
Phone: 615-552-8080	
Zinc Dust	3339
Zinc Oxide	2816
REFINED METALS CORP.	
Memphis (Shelby Co.) TN	
Market: Multistate; Workers: 150	
Phone: 901-775-3770	
Lead Refining	3339
Antimonial Lead Alloys	3341
SAVAGE ZINC	
Clarksville (Montgomery Co.) TN	
Market: Local; Workers: 650	
Phone: 615-552-4200	
Zinc Metal Refining	3339

SAVAGE ZINC INC.	
Gordonsville (Smith Co.) TN	
Market: Local; Workers: 250	
Phone: 615-683-6411	
Zinc Ore Mining	1031
Zinc Concentrate	3339
SPECIALTY ALLOYS CORP.	
Gallaway (Fayette Co.) TN	
Market: National; Workers: 30	
Phone: 901-867-2126	
Alloy Briquettes	3325
Silicon-Manganese Briquettes	3339

3341 Secondary Smelting & Refining of Nonferrous Metals

ALLOY EXCHANGE	
Newbern (Dyer Co.) TN	
Market: Int'l; Workers: 5	
Phone: 901-627-3251	
Metal Processing	3341
ALUMINUM CO. OF AMERICA	
Alcoa (Blount Co.) TN	
Market: Int'l; Workers: 2100	
Phone: 423-977-2011	
Aluminum	3334
Recycle (Smelt) Aluminum	3341
CHATTANOOGA RECYCLED FIBER	
Chattanooga (Hamilton Co.) TN	
Market: Local; Workers: 19	
Phone: 423-267-0097	
Paperboard	2631
Aluminum	3341
CONTECH CONSTRUCTION PRODUCT INC.	
Nashville (Davidson Co.) TN	
Market: National; Workers: 400	
Phone: 615-297-9278	
Drainage Products	3259
Geotextiles	3229
Plastic Storm Sewer Pipe	3083
Retaining Walls	3253
Bridge Decking	3441
Bridge Structures	3341
Pavement Reinforcement Fabric	3069
Corrugated Metal Pipe	3316
GENERAL SMELTING & REFINING INC.	
College Grove (Williamson Co.) TN	
Market: Multistate; Workers: 45	
Phone: 615-368-7125	
Refined Metal	3339
Lead Products	3341
IMCO RECYCLING INC.	
Loudon (Loudon Co.) TN	
Market: National; Workers: 64	
Phone: 423-458-2007	
Secondary Aluminum Smelting	3341
IMCO RECYCLING INC.	
Rockwood (Roane Co.) TN	
Market: Int'l; Workers: 150	
Phone: 423-354-3626	
Recycle Aluminum Cans	5093
Scrap Aluminum Ingots	3341
KNOX METALS CORP.	
Knoxville (Knox Co.) TN	
Market: National; Workers: 45	
Phone: 423-637-4353	
Scrap Iron	5093
Nonferrous Metals	3341
PERLCO	
Memphis (Shelby Co.) TN	
Market: Int'l; Workers: 39	
Phone: 901-526-7651	
Scrap Steel Processing	5093
Nonferrous Metal	3341
PGP SILVER PROCESSING	
Coalfield (Morgan Co.) TN	
Market: National; Workers: 18	
Phone: 423-435-1704	
Recover Silver from Film	3341

REFINED METALS CORP.	
Memphis (Shelby Co.) TN	
Market: Multistate; Workers: 150	
Phone: 901-775-3770	
Lead Refining	3339
Antimonial Lead Alloys	3341
SMELTER SERVICE CORP.	
Mount Pleasant (Maury Co.) TN	
Market: National; Workers: 40	
Phone: 615-379-7765	
Aluminum Smelting	3341
SOUTHERN FOUNDRY SUPPLY INC.	
Chattanooga (Hamilton Co.) TN	
Market: National; Workers: 200	
Phone: 423-756-6070	
Recycled Metal	3341
STEINER-LIFF IRON & METAL CO.	
Nashville (Davidson Co.) TN	
Market: Int'l; Workers: 175	
Phone: 615-271-3300	
Scrap Metal	5093
Scrap Iron	3341
Metal Processing	3341
STURDY LITE INC.	
Bristol (Sullivan Co.) TN	
Market: National; Workers: 10	
Phone: 423-968-7021	
Aluminum Extrusions	3341
TECHNICAL PLATING & RUBBER INC.	
Watertown (Wilson Co.) TN	
Market: National; Workers: 28	
Phone: 615-237-9767	
Alodine	3471
Plastisol Coating	3479
Electroplating & Plating	3471
Polyurethane	3089
Silver/Tin	3356
Electroless Nickel	3356
Zinc Plating	3341
TWIN CITY IRON & METAL CO., INC.	
Bristol (Washington Co.) VA	
Market: Multistate; Workers: 23	
Phone: 540-466-2022	
Metal Processing	3341
UNITED STATES BRONZE POWDERS INC. - ROYAL DIV.	
Maryville (Blount Co.) TN	
Market: Int'l; Workers: 18	
Phone: 423-982-8096	
Copper Smelting	3341
WABASH ALLOYS INC.	
Dickson (Dickson Co.) TN	
Market: Multistate; Workers: 70	
Phone: 615-446-0600	
Aluminum Foundry	3365
Aluminum Smelting	3341

3351 Rolling, Drawing & Extruding of Copper

APACHE GROUNDING	
Portland (Sumner Co.) TN	
Market: National; Workers: 4	
Phone: 615-449-1962	
Galvanized Grounding Rods	3312
Copper Grounding Rods	3351
HUDSON INTERNATIONAL CONDUCTORS	
Trenton (Dade Co.) GA	
Market: National; Workers: 60	
Phone: 706-657-7541	
Magnet Wire	3351
Thin Wall Tubing	3599
W. BOMAS MANUFACTURING CO. INC.	
Nolensville (Williamson Co.) TN	
Market: National; Workers: 4	
Phone: 615-776-2840	
Copper & Brass Gift Items	3999
Aluminum Gift Items	3999
Brass Railings	3351
Architectural Brassware	3351